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VOL. CXLII.—No. 3688] LONDON: FRIDAY EVENING, SEPTEMBER 17, 1926 [PRICE WITH SUPPLEMENT ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1. invites TENDERS for :—

225 TONS ROLLED STEEL JOISTS.

Tenders due on the 28th September, 1926.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returnable. 3566

Assistant Engineers (10) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E. or possess a degree in civil engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. They must have had proper technical training and preferably have had not less than two years' subsequent experience on large engineering or municipal works. Candidates possessing other civil engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485. 3526

British Guiana.
MAYOR AND TOWN COUNCIL OF GEORGETOWN.
APPOINTMENT OF CITY ENGINEER.

APPLICATIONS are INVITED by the Mayor and Town Council of Georgetown for the APPOINTMENT of CITY ENGINEER of GEORGETOWN, a city with population 55,000 and area of approximately 2¼ square miles.

Candidates must be Chartered Civil Engineers or Members or Associate Members of the Institution of Civil Engineers, or have obtained the Testamur of the Institution of Municipal and County Engineers, and have wide experience in the designing and carrying out of works, especially waterworks, sewerage and sewage disposal (pumps being operated by electricity), surface drainage, and construction of streets; experience in reinforced concrete construction is desirable.

Special consideration will be given to applications of candidates with an Honour Degree in Engineering.

No candidate will be considered unless he is over 30 and under 45 years of age on 1st October, 1926.

The salary offered by the Council is £1200 per annum, with annual increment after the second year of £50 per annum until the salary reaches £1350 per annum. A motor car will be provided and maintained.

The successful candidate will be appointed on two years' probation and will be required to reside at the waterworks in the new residence, for which he will pay a rental of £100 per annum, to devote the whole of his time to the duties of the office, and not to engage in private practice or any other duty or employment.

The appointment and dismissal of City Engineer are according to law made by the Council subject to the concurrence of the Governor-in-Council of the Colony.

The appointee will be entitled under the Council's leave regulations to 3 months' vacation leave on full pay for every completed 3 years of service, and the Council may award a pension for satisfactory long service.

The successful applicant will be required to pass satisfactorily a medical examination before assuming office, and to be in the Colony on or about the 1st December, 1926.

By law the City Engineer is required to give security by himself and two sureties jointly and severally in a sum to be determined by the Council for the true and faithful performance of his duties and for the due and punctual accounting for and payment of all moneys received by him. The Council has determined that sum to be £625.

Applications must state age, experience and qualifications and be accompanied by not more than four recent testimonials from some recognised engineering authority and Borough or other Municipal Corporation.

All applications should be addressed to the TOWN CLERK, Town Hall, Georgetown, Demerara, British Guiana, care of the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, not later than 15th October, 1926, and envelopes endorsed in top left-hand corner "City Engineer, Georgetown, British Guiana." 3527

Chelsea Polytechnic,
MANRESA-ROAD, CHELSEA, S.W. 3.
SPECIAL CLASSES IN ENGINEERING METALLURGY.

In addition to the Courses in General Metallurgy, arrangements have been made for Special Courses of Lectures and Practical Work :—

(a) Engineering Metallurgy. Syllabus arranged to cover the syllabus of the Institution of Mechanical Engineers' Associateship Examination in Metallurgy.
(b) Heat Treatment of Metals.
(c) Testing and Mechanical Working of Metals.

The above classes are suitable for Engineers, Consultants, Engineering Students, Works Metallurgists.

COURSES BEGIN 20th SEPTEMBER, 1926.

Full details on application.

Tels., 0809 and 8007 Kensington. 3544

NORTHERN POLYTECHNIC,
HOLLOWAY, London, N. 7.

PRINCIPAL :—REG. S. CLAY, B.A., D.Sc.

COMPLETE COURSES IN THE DESIGN OF STRUCTURAL STEEL AND REINFORCED CONCRETE STRUCTURES.

Mathematics, Mechanics, Materials.

NEW TERM SEPTEMBER 27TH, 1926.

Fees—£1 10s. per course per session.

Head of Department, T. P. BENNETT, F.R.I.B.A. 3489

The Engineer

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PUBLIC NOTICES

Portsmouth Municipal College.
Full-time Day Courses in MECHANICAL, CIVIL, and ELECTRICAL ENGINEERING of two, three, or four years' duration are available in preparation for the Diploma or Associate Membership Examinations of the Professional Institutions and for the B.Sc. Engineering Degree of the London University.

The College laboratories and workshops are well equipped with experimental plant and apparatus, including Steam Turbine Generators, Coal and Oil-fired Boilers, &c., an excellent assortment of Standard Testing Appliances and Modern Machine Tools.

Session now commencing.

For further particulars and copy of the College prospectus apply to the SECRETARY.

N.9.9.26. 3532

The University of Sheffield.
SESSION 1926-27.
Vice-Chancellor: SIR HENRY HADOW, C.B.E., D.Mus., LL.D.

DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.

The Courses in the above Departments extend over three or four years and prepare students to become specialists in one or other of these branches of Applied Science.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular Courses.

In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering, and in Glass Technology, arrangements are made to enable students who come to the University from works or collieries to take six months' Courses of study at the University and six months' practice at the works or colliery each year for a period of four years. During the first year such students should spend three terms at the University.

The LECTURE COURSES commence OCTOBER 6th, 1926.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 28th, 1926.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to

W. M. GIBBONS, Registrar.

3023

PUBLIC NOTICES

The Institution of Structural Engineers.
The first MEMBERSHIP COMMITTEE MEETING of the new Session will be held on OCTOBER 6th, and intending candidates should forward their applications before 4th October. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY,
Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1. 3559

The Institution of Structural Engineers.
MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.

A MODIFIED EXAMINATION for ASSOCIATE-MEMBERSHIP for candidates of and over 25 years of age who have at least 10 years' experience (including time served in apprenticeship or articles) is HELD QUARTERLY. It consists of an examination in Design worked privately by the candidate in the course of his practice at home. The NEXT EXAMINATION will take place on 18th SEPTEMBER (papers posted on the 17th), and entries must be in by 13th September. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY,
Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1. 3135

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 1st October, TENDERS for the SUPPLY of :—

RAILWAY TICKETS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion, 91, Petty France, S.W. 1.
15th September, 1926. 3568

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—

FOUR 12ft. CLEAR DECK SPANS (approx. weight 150 tons).
SIX 60ft. CLEAR DECK SPANS (approx. weight 150 tons).

Tenders are due in on Tuesday, 12th October, 1926, by 10.30 a.m. Tender forms obtainable at above address; fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 3558

PUBLIC NOTICES

Administrative County of LONDON.
BLACKWALL AND ROTHERHITHE TUNNELS, SCAVENGING, &c.

The London County Council invites TENDERS for the REMOVAL and DISPOSAL of SLOP and REFUSE from, and the SUPPLY and DELIVERY of HOGGIN and SAND to, BLACKWALL and ROTHERHITHE TUNNELS during the twelve months commencing 20th December, 1926.

Persons desiring to submit Tenders may procure a form of Tender on application to the Chief Engineer of the Council, at the Old County Hall, Spring-gardens, S.W. 1. No Tender received after 4 p.m. on Monday, 11th October, 1926, will be considered.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
3557 Clerk of the London County Council.

Belper Urban District Council.
CONTRACT NO. 2.

The Belper Urban District Council invite TENDERS from contractors for LAYING about 1100 YARDS of 5in. WATER MAIN from Bessylean Reservoir to Heage Boundary at Belper.

Plan and specification may be seen and particulars obtained from the Consulting Engineers, Messrs. G. and F. W. Hodson, M. Inst. C.E., Bank Chambers, Loughborough, on deposit of £5 5s., which will be refunded to bona fide tenderers on return of the documents. Plans may also be seen at the Council Offices, Belper.

Tenders, on the form supplied, to be sent to the undersigned not later than Saturday, 2nd October, 1926.

The Council do not bind themselves to accept the lowest or any Tender.

Dated 9th September, 1926.

J. PERCY R. PYM,
Clerk to the Council.
Belper. 3528

City of Liverpool.
CITY ENGINEER'S DEPARTMENT.
PNEUMATIC CRUDE SEWAGE EJECTORS AND ELECTRICALLY DRIVEN AIR COMPRESSORS.

The Corporation are prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION at the West Derby Sewage Farm, Fazakerley, Liverpool, of :—

2 NEW COMPLETE SETS of PNEUMATIC CRUDE SEWAGE EJECTORS and ELECTRICALLY DRIVEN AIR COMPRESSORS.

Form of Tender will be forwarded upon receipt of application in writing to

The City Engineer,
Municipal Buildings, Dale-street, Liverpool.

Tenders must be sealed and endorsed in accordance with the instructions given on the form of Tender and must be forwarded through the post, addressed to

The Town Clerk,
Municipal Buildings, Liverpool.

Latest time and date for receipt of Tenders Ten o'clock a.m. on Tuesday, the 5th October, 1926.

WALTER MOON,
Town Clerk.
16th September, 1926. 3525

Great Southern Railways.
STEEL FISH-PLATES AND PITCH PINE LOGS.

The Directors of the Great Southern Railways (Ireland) are prepared to receive TENDERS for the SUPPLY of :—

100 TONS of STEEL FISH-PLATES for 94 lb. RAILS.
200 LOADS of PITCH PINE LOGS, not less than 35 cub. ft. average.

Specifications and forms of Tender (on which alone offers will be considered) can be obtained on application to the Company's Stores Superintendent, Inchicore, Dublin, on payment of Two Shillings and Sixpence for each Tender form.

Tenders should be forwarded so as to reach the undersigned not later than 10 a.m. on Thursday, 23rd September, 1926, in the envelope provided for the purpose.

The Directors do not bind themselves to accept the lowest or any Tender.

C. E. RILEY,
Secretary.
Kingsbridge Station, Dublin, September, 1926. 3529

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PUBLIC NOTICES

Egyptian Government.

The Ministry of Public Works, Mechanical Department, is calling for TENDERS for the SUPPLY and ERECTION at site of SERU PUMPING and POWER STATION of FOUR DIESEL ENGINE ALTERNATOR GROUPS, THREE PUMPS and ACCESSORIES. Tenders will be received only at the office of the Director-General, Mechanical Department, Ministry of Public Works, Cairo, up to Noon, 1st January, 1927.—Copies of the specification, conditions of Tender and drawings may be obtained against a payment of 10s. 6d., which is not returnable, from the CHIEF INSPECTING ENGINEER, Egyptian Government, 41, Tothill-street, London, S.W. 1. 3538

County of London.

The London County Council invites APPLICATIONS for the POSITION of ELECTRICAL ENGINEER in its Tramways Department.

The salary will be £1200 a year, rising by annual increments of £50 to a maximum of £1500 a year. The salaries mentioned are based on pre-war conditions and are subject at present to temporary additions on the Civil Service scale, fluctuating according to the cost of living. The total commencing remuneration on the existing basis is £1404 15s. 10d. a year, but the temporary additions will be revised not later than 1st March, 1927.

Candidates must be qualified electrical engineers, accustomed to a position of superior responsibility in an electrical power undertaking, and experienced in the design, construction, &c., of generation and distribution plant and equipment, and the organisation and control of a large staff. The age of candidates must not exceed 50 years on the latest date for the receipt of applications. Preference will be given to candidates who served or attempted to serve with H.M. Forces during the Great War.

Applications must be on forms (containing full details) to be obtained from the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary). Forms must be returned so as to be received not later than Tuesday, 5th October, 1926. Canvassing disqualifies.

MONTAGU H. COX,
3186 Clerk of the London County Council.

Severalls Mental Hospital,

COLCHESTER.

WANTED, RESIDENT ASSISTANT ENGINEER and CLERK of WORKS. Must be capable man, steady and thoroughly reliable, fully qualified to take charge of power station, consisting of steam boilers, steam and oil engines, dynamos, switchboards, pumps, &c.

Candidates must be capable of supervising and undertaking repairs, &c., at such times as may be necessary. In addition, should have a knowledge of building construction and repairs. Only first-rate men will be considered.

Wages £5 per week. A cottage, together with firing and light, is provided within the Hospital grounds, and for which a reasonable weekly charge is made.

The appointment is subject to the terms of the Asylums Officers' Superannuation Act, 1909.

Applications, stating age (which should not exceed 40 years), experience, &c., and accompanied by copies of three recent testimonials, to be made upon forms obtainable by enclosing stamped addressed envelope to the MEDICAL SUPERINTENDENT. 3543

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, ENGINEERS' COMMERCIAL CLERK, one experienced in costing, estimating, bookkeeping, with knowledge of mechanical drawings, active. To one of initiative, progressive post assured.—Address in confidence, stating abilities, age, experience, P2234, The Engineer Office. P2234 A

ASSISTANT ENGINEER REQUIRED for Large Factory in the Argentine. Must be of good standing and education, having had highest grade all-round technical training with subsequent experience of Steam Plant (including Evaporating and Condensing), Electrical (Direct Current), and General Mechanical Engineering. Experience of process working and factory routine also desirable. Permanent position with good salary and prospects for suitable man.—Applications, stating age, which must not exceed 35, salary required, and qualifications, with copies of testimonials, write to "N," c/o Street's, 6, Gracechurch-street, E.C. 3. 3567 A

CHARTERED CIVIL ENGINEER has VACANCY for recently graduated B.Sc. or TECHNICAL COLLEGE GRADUATE wishing to enter profession. Small salary.—Address, P2244, The Engineer Office. P2244 A

ENGINEER-SALESMAN WANTED, to Act as District Representative of well-known London Company in the North of England. Sound sales and engineering experience essential. Preference given to resident in district. Salary, commission, expenses.—Apply, giving fullest details and salary required, to Box 71, c/o Mather and Crowther, Ltd., 16/18, New Bridge-street, E.C. 4. 3400 A

ESTIMATING CLERK WANTED, Midlands, thoroughly conversant with Power Transmission Business.—Address, 3554, The Engineer Office. 3554 A

REPRESENTATIVE REQUIRED for London District, with experience preferred as Heating Engineer, to call upon architects, consulting engineers, &c., with a view to obtaining inquiries for Heating and Ventilating Plants, Cast Iron Pipes and other manufactures. Must be energetic, of good address, and well known amongst architects. Good income assured to a suitable applicant.—Address, P2255, The Engineer Office. P2255 A

WANTED by London Firm of Constructional Engineers, smart young DRAUGHTSMAN, able to design and take out quantities. Only those with the necessary experience need apply. State age, salary, and experience.—Address, 3569, The Engineer Office. 3569 A

WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN; must have considerable experience in both Wood and Steel Construction.—Apply by letter, stating experience and salary required, THE BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 3522 A

WANTED, First-class DRAUGHTSMAN for Tanks, Pipes, Structural Steel Work. Knowledge of Gasworks Plant an advantage.—State age, salary, and experience to THOS. PIGGOTT and CO., Spring Hill, Birmingham. 3564 A

WANTED, Good DRAUGHTSMAN, Accustomed to Heavy Engineering Work and preferably with experience in design of Pneumatic Hammers and Rolling Mill Auxiliary Machinery.—Address, P2263, The Engineer Office. P2263 A

WANTED, JUNIOR DRAUGHTSMAN for Engineer's Office; also REFRIGERATING DRAUGHTSMAN.—Address full particulars, 3533, The Engineer Office. 3533 A

DRAUGHTSMAN, First class, Experienced in Air and Mechanical Injection Heavy Oil Engines. Shop and testing experience desirable. State age, experience, and salary.—Address, P2257, The Engineer Office. P2257 A

DRAUGHTSMAN.—First-class Mechanical MAN WANTED by Firm in London district, for Design of Intricate Electrical Apparatus. Must be thoroughly sound technically and have had experience in up-to-date methods of production. Only men of undoubted ability as mechanical designers need apply.—Address, stating age and salary required, 3548 The Engineer Office. 3548 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED, with General Engineering knowledge, structural and mechanical. Applicants should state age, experience, and wages required and when at liberty.—Address, P2248, The Engineer Office. P2248 A

DRAUGHTSMAN REQUIRED, Well Up in General Machine Design and Construction; some experience in Lay-out Work an advantage.—Apply, stating age, technical training, experience, and salary required, to SECRETARY, J. S. Fry and Sons, Ltd., Union-street, Bristol. Mark envelope "Draughtsman." 3536 A

DRAUGHTSMAN REQD., London, with Good Exp. of Water-tube Boilers ess. Good sal. and prospects to capable man.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 3541 A

DRAUGHTSMAN, Senior, REQUIRED by Engineering Firm, Glasgow district; up-to-date practical experience in design and manufacture of Steam Fittings for high pressures and superheat. State age, experience, and salary required.—Address, 3484, The Engineer Office. 3484 A

DRAUGHTSMEN, SENIOR, WANTED for Commercial Vehicle Chassis Design. Familiar with necessary calculations and work with minimum of supervision; no engine experience necessary.—Address, experience, age, salary, 3534, The Engineer Office. 3534 A

DRAUGHTSMAN WANTED by Confectionery Firm, accustomed to General Engineering Work Machinery Design and Plant Lay-out). Five days week, £4 5s., rising to £5 after six months.—Address, 3509, The Engineer Office. 3509 A

DRAUGHTSMAN WANTED in London District, with a thorough knowledge of detailing Structural Steel Work.—Address, giving age, particulars of experience, and salary required, 3563, The Engineer Office. 3563 A

OIL ENGINES.—Experienced DRAUGHTSMEN REQUIRED at once for Detail Work on Heavy Oil Engines; must be accustomed to calculating Stresses, &c. State full details of experience, age and salary required.—Address, 3511, The Engineer Office. 3511 A

SITUATIONS OPEN (continued)

REQUIRED, First-class MECHANICAL DRAUGHTSMEN for London. Application by letter, giving particulars of age, experience, salary expected.—Address, 3546, The Engineer Office. 3546 A

REQUIRED, Several First-class AERONAUTICAL DRAUGHTSMEN, with good experience in detail design.—State age, experience, salary required, and when at liberty to BLACKBURN AEROPLANE and MOTOR CO., Ltd., Brough, E. Yorks. 3555 A

STRUCTURAL DRAUGHTSMAN REQUIRED, North-East Coast; must be a competent detailer, capable of accurate work without supervision.—Address, stating age, experience, and salary required, 3562, The Engineer Office. 3562 A

FOREMAN REQUIRED for Small Boiler Works with output of 300 vertical boilers per annum. Should have experience in manufacture of Vertical and Cornish and Small Loco. Boilers. State age, experience, and salary.—Address, 3561, The Engineer Office. 3561 A

SITUATIONS WANTED

WORKS MANAGER DESIRES CHANGE, 15 Years' experience as works manager in first-class engineering firms; speciality, output, organisation, and efficiency.—Address, P2169, The Engineer Office. P2169 B

ADVERTISER (22) SEEKS POST as ENG. ASSIST. or in D.O., civil or mech. University training. D.O. and workshop exp. London dist. now disengaged.—Address, P2251, The Engineer Office. P2251 B

ENGINEER SEEKS POST, Home or Abroad; 16 years' exp. design and prod. m/c. tools, general, jigs, &c. Versatile, linguist.—Address, P2256, The Engineer Office. P2256 B

ENGINEER (25), Good Technical Education, 6 Years' apprenticeship with firm of loco. builders, 18 months works maintenance, studying for A.M.I. Mech. E., DESIRES POST.—Apply, PRICE, 19, South-street, Kimberworth, Rotherham. P2246 B

ENGINEER (40), D.O. and Works Exp. in General mech. and chem. engineering, tar products, boiler eff. tests, charge gen'l factory plant, control labour, SEEKS OPENING.—Address, P2225, The Engineer Office. P2225 B

EXPANSION BEND BRITISH PATENT No. 217,185.

Small pressure and radiation losses.

Large range of Expansion.

Special machines for manufacture are not necessary.

This type of expansion bend has been in use throughout Germany for over three years and has shown itself superior to all other types.

Greatest Reliability in Service.

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. . THE . .

PREMIUM SYSTEM of PAYING WAGES

A few copies of this book, the standard work on the subject, are left. They form part of the fifth edition, which was revised to meet the great demand.

Copies in cloth boards, Two Shillings and Sixpence each net.

Post free to any address in the United Kingdom, 2s. 9d.

"THE ENGINEER" Office, 33, Norfolk Street, Strand, W.C.

SITUATIONS WANTED (continued)

EXPERIENCED STRUCTURAL ENGINEER and INDUSTRIAL WORKS DESIGNER WISHES to HEAR of MANUFACTURERS intending to Build and Lay Out New Works or Extensions. Would take entire responsibility as Temporary Resident Engineer to superintend the carrying out of same if desired.—Address, P2258, The Engineer Office. P2258 B

SUCCESSFUL ENGINEER, with Wide Experience of Railways and of a variety of Engineering Works and possessing the faculties of versatility, invention and organisation, SEEKS POSITION as MANAGING DIRECTOR or as GENERAL MANAGER with a seat on board of a Large and Progressive Company, at home or abroad. Highest references.—Address, P2253, The Engineer Office. P2253 B

YOUNG ENGINEER, Public School, British Railway training, present continental inspection work, DESIRES APPOINTMENT Firm of Engineers or Agents, preferably commercial side. French, German.—Address, P2262, The Engineer Office. P2262 B

DRAUGHTSMAN (London District) REQUIRES SITUATION; 21 years' good all-round engineering experience.—Address, P2232, The Engineer Office. P2232 B

DRAWINGS, TRACINGS, True-to-scale and Other PRINTS expeditiously PREPARED by Draughtsman; ideas economically developed; specialist in Steam and Petrol Lorry and Car Designs. A.M.I. Mech. E.—Address, P2254, The Engineer Office. P2254 B

ENGINEER and DRAUGHTSMAN, London; 12 years shops, 14 years office, all-round experience, or could undertake private work.—Address, P2265, The Engineer Office. P2265 B

EXPERT DESIGNER and ESTIMATOR, Heavy, medium and special machine tools, DESIRES progressive POSITION, works or D.O. Able to control staff.—Address, P2259, The Engineer Office. P2259 B

ENGINEER DRAUGHTSMAN, Varied Exp. General engineering, SEEKS responsible POST where accuracy of design, competence for handling contracts, ability to lead staff, and initiative in organising production will gain outlet.—Address, P2261, The Engineer Office. P2261 B

LADY TRACER (Junior) REQUIRES POSITION. Holds tracing school diploma. Blue print from specimen tracing furnished.—K. GREEN, 92, Crescent-road, Plumstead, S.E. 18. P2264 B

MECHANICAL DRAUGHTSMAN, 35 Years of Age, married, DESIRES CHANGE; 12 years' D.O. exp. and shops, technical college education, general engineering design and lay-outs, conveying machinery, lifts, printing and pumping plants. Salary £360 per annum.—Address, P2249, The Engineer Office. P2249 B

GENERAL SMITH, HYDRAULIC PRESS and ANGLE FOREMAN (age 36) DESIRES progressive POSITION. Disciplinarian and good organiser.—Address, P2260, The Engineer Office. P2260 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 75 years.

£5000 REQUIRED by Manufacturer with Method which Saves 50 per cent. Material used in Making Tool of universal demand.
Good opportunity engineer. Principals only. Address, P2233, The Engineer Office. P2233 C

For continuation of Small Advertisements see page 3.

INTERNAL COMBUSTION

TWENTY YEARS AGO the Internal Combustion Engine had practically not been used for vehicles running on Rails. The early Drewry Cars built about that time were received with suspicion by Railway Engineers, who prophesied breakdowns and disorganisation of traffic if they were used. The Drewry Car Company, however, disproved all that by placing a reliable car on the market. It took a long time to overcome prejudice, but it is on record that the Company were undoubtedly pioneers in the use of the Internal Combustion Engine on Railways. To-day this form of traction is an accepted fact and its uses and scope are widening almost daily. The Drewy Car Company have moved with the times and still hold the premier position as manufacturers of a very wide range of high grade Rail Cars, Coaches and Locomotives which are to be found giving satisfactory service on over 300 Railways in every part of the globe. If you have a Transport Problem, why not apply to them?

COACHES, TRAMCARS, INSPECTION CARS & LOCOMOTIVES.

THE DREWRY CAR COMPANY LTD.
13, SOUTH PLACE, LONDON, E.C. 2.

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A Seven-Day Journal

New British Destroyers.

SPECIAL interest will attach to the steam trials of H.M.S Amazon, the destroyer built by John I. Thornycroft and Co., Ltd., which are to begin on Tuesday next—September 21st. The Amazon and Ambuscade were authorised under the 1924–25 Navy Estimates, the contract for the last-named boat being awarded to Yarrow and Co. They are the first destroyers to be constructed in this country since the war. It is understood that they have been built to independent designs, governed only by certain essential features specified by the Admiralty. There is, in consequence, a marked difference between the vessels, the Amazon displacing 1330 tons and the Ambuscade 1210 tons. The machinery of each vessel consists of geared turbines and oil-burning boilers, the contract speed being 37 knots. The armament is four 4·7in. guns, seven 2-pounder and machine-guns, and two triple torpedo tubes. Other particulars are withheld for the present. The Amazon was laid down at Woolston in January, 1925, and was to have been launched on January 16th this year, but owing to the freezing of the slipway, she did not go afloat until January 27th. She is 30 tons smaller than the Wishart and Witch, the largest destroyers now on the Navy List, but her speed of 37 knots is the highest for which any destroyer has ever been designed. The Ambuscade, begun on December 8th, 1924, was launched on January 14th last, and will shortly make her trials. The five-year building programme now in operation includes twenty-seven new destroyers, which are to be laid down in three groups, each comprising nine boats, from 1927–8 to 1929–30.

Underground Railway Extensions.

ON Monday, September 13th, the connecting line of the London Electric Railways, between Charing Cross, Waterloo and Kennington and the extension of the City and South London Railway from Clapham Common to Morden, were brought into use. The official ceremony was performed by Lieut.-Colonel Moore-Brabazon, the Parliamentary Secretary to the Ministry of Transport, who caused the starting signal at Clapham South to assume the "clear" position, and subsequently drove the official special train to Morden. At a luncheon, Lieut.-Colonel Moore-Brabazon said, on the subject of State aid for London transit schemes, that the Government could not give assistance to any one city. The remedy he advocated was co-operation among the various interests and not competition. If the transportation problem of London were considered as one item, there might be room not only for the derelict tramways to pay but for the construction of new tubes in other parts of London. Lord Ashfield, the chairman of the railway company, in reply, said that the extensions opened that day had cost £5,000,000, which were part of the £21,000,000 spent by the Underground on railways since the war. To make the new works pay for themselves they must carry 14,000,000 passengers per mile per year. In any scheme of co-ordination for London traffic there must be fair, and not extravagant, co-operation; it must not be left to any organisation to select what form of transport it would carry and so take the cream and leave the skimmed milk to the others. A very gratifying feature of Lord Ashfield's speech was the testimony he bore to the engineers and contractors associated with the work, and particularly did he regret the absence of Mr. Knapp, the director for construction. Very striking, too, was his observation that the efforts of the officers of the Underground and of the 45,000 men it employed were a great inspiration to him, for which he was very grateful.

The New River.

THE twentieth annual report submitted by Sir Alexander Houston, director of water examination, to the Metropolitan Water Board is this year something much more than a statement of the results of chemical and bacteriological examination of the London waters during a period of twelve months. Sir Alexander's reports, as our readers have learned in the past, are always free from dullness and mediocrity. This year he has far surpassed all his previous efforts, and has produced a report which, besides the usual statistics and records of fact, contains a lengthy history of the New River. He calls it the "Romance of the New River," and the title is well chosen. In his scholarly hands he traces the story of Myddelton's great beneficent venture undertaken over three hundred years ago, and does so in a manner and with a joy in his subject which will find a response in many of the readers, lay as well as scientific, who will be attracted by the subject. The history is very fully illustrated by means of several unorthodox maps and numerous delightful photographic reproductions of views on the "river" and of places of historical or other interest along its course. Some may question the value or propriety of introducing a lengthy historical essay into an annual report such as Sir Alexander's. Let any who will criticise the matter in a strictly utilitarian manner. The aim has been to interest Londoners in their wonderful water supply, and to teach them the value of its purity. That aim, approached in a spirit of romance, has been achieved in a manner which removes the last excuse for criticism. In publishing the "Romance of the New River" separately from, as well as part of, Sir Alexander's annual report, the Metropolitan Water Board has, we are certain, correctly foreseen the demand that will be made for it, not as a work of reference, but as a companionable and chatty volume for a winter night's reading, or to accompany one's walks in summer in the New River district.

A Threatened Oil Famine.

ABOUT two years ago the growing concern felt in the United States regarding the country's mineral oil resources led the President to appoint a special Federal Oil Conservation Board to inquire into the position. That Board recently submitted its report to Mr. Coolidge after a thorough and careful investigation. The Board, consisting of four members of the Cabinet, finds that the crude oil reserves in the United States which are known to exist amount to 189,000 million gallons, or enough to last at the present rate of consumption for not more than six years. The report expresses fears as to what would happen should the country become dependent for its oil supplies on foreign nations, and urges that, in addition to a strict conservation of supplies, efforts should be directed towards the acquisition of all available foreign oil reserves. The subject is one which concerns this country, for both our crude oil and our motor spirit imports still come in part from the United States. We are, however, far from being dependent upon America for our supplies. It is true that of the motor spirit imported in 1924 a little over 70 per cent. was received from the States, but of our crude petroleum imports 82 per cent. were sent to us by Persia, and of our refined fuel oil imports 64 per cent. were received from Mexico. Any famine of oil in the United States would thus clearly affect that country primarily to a much greater actual and relative degree than it would this country.

Scapa Flow Salvage Operations.

DURING the last week or so preparations have been made by Cox and Danks, Ltd., at Scapa Flow to transfer salvage appliances to the overturned and submerged battleship Möltke, it having been decided to abandon further work on the battle-cruiser Hindenburg, in face of the heavy storms which sweep over the Orkney Islands at this season of the year. In a Journal note of August 20th, we indicated some of the measures which had been taken in order to preserve that ship on an even keel during the final pumping operations. Before the last attempt to lift her was made a cofferdam was built round her forward turret to allow her to take with safety a larger list. The four pontoons from which the operations were conducted were all brought round to the starboard side of the ship, and steel hawsers passed under the stern were made fast to winches on the pontoons. When, however, pumping was started in the forward compartments, the angle of list increased from 21 deg. to over 33 deg., when the vessel practically rested on her port bilge. In this precarious position she remained for over a day, resisting all the efforts which were made to right her. Subsequently a heavy westerly gale sprang up and the position of the ship was actually shifted by the force of the wind, so near was she to floating. At one time it was feared that the Hindenburg would turn turtle, and at the height of the storm it was decided to sink her again.

The Coal Dispute.

WHEN the Chancellor of the Exchequer invited the Mining Association to meet the Government in a tripartite conference with the Miners' Federation, he had in mind the possibility of some scheme being evolved whereby the owners' insistence upon district settlements might be harmonised with the miners' demand for a national settlement. The secretary of the owners' association made it clear last week that his members regarded national settlements, by linking the industry with politics, as destructive of peace and prosperity, and as menaces to the community. He agreed, however, to remit the question of taking part in the proposed conference to the colliery owners' district associations, although he held out no hope that his association would be empowered by the district organisations to negotiate a national settlement on their behalf. That anticipation has been fully borne out by the letter sent by Mr. Williams to the Chancellor on Monday, September 13th. With the exception of one small inland district in Warwickshire, all the twenty-four district associations, Mr. Williams informed the Chancellor, had declared against giving the central body power to enter into agreements regarding terms of employment. They were, he added, still willing to meet the local miners' associations at any time, and none of them raised any objection to the principle of regulating wages by results or the payment of minimum percentages and subsistence wages. The proposed meeting in these circumstances would, it was held by Mr. Williams, serve no good purpose, but would expose those taking part in it to a charge of insincerity. While the deadlock thus continues, the drift of the miners back to the pits continues to grow. On Wednesday of this week over 74,000 miners were reported to be at work at pits in the Warwickshire, Leicester, Cannock Chase, Notts. and Derby, and Lanarkshire districts.

New Dock Extensions at Southampton.

ON Friday of last week, September 10th, the Southern Railway Company placed a contract with the James Dredging, Towage and Transport Company, Ltd., for the reclamation of about 18 acres of land adjacent to the Royal Pier at Southampton. The contract marks the beginning of the new dock extension scheme, which, when completed, will, it is stated, cost about £13,000,000, and will provide 16,600ft. of additional quayage, and accommodation for no less than twenty of the world's largest liners. The first section of the work, of which the contract referred to forms a part, is to be completed within four years, and will cost about £3,000,000. Besides providing the port with 3500ft. of new quay accommodation, it includes the remodelling of the Southampton West Station and the extension of the railway to Millbrook. The existing level crossing at the West Station is also to be replaced by a bridge. The new quay wall will be extended to a length of 7500ft., when the second stage of the work is begun, and further land will be reclaimed. The third stage of the work, which will only be undertaken as the port requirements demand, involves the construction of a long jetty parallel to the new quay wall, which, when completed, will bring up the total length of quay accommodation to the 16,600ft. already referred to. The new scheme is a modification of the original plan, which, it will be remembered, provided for the construction of five jetties, each 1000ft. long, which would project from the reclaimed area. For this reason fresh parliamentary sanctions have to be sought, but if the Corporation and the Harbour Board approve of the scheme, as is already foreshadowed, then it is understood that the Southern Railway Company will approach the Board of Trade for permission to proceed with the work pending the passing of a new Bill.

The 1000ft. Ocean Liner.

DURING the last few weeks considerable interest has been aroused in shipbuilding circles concerning the problems involved in the construction and operation of a 1000ft. ocean liner. Such interest has naturally followed Mr. P. A. S. Franklin's announcement in August that the plans for the development of the White Star Line included the building of a 62,000-ton ship, and the statement of the Cunard Steam Ship Company, Ltd., to the effect that it also was interested in the question of larger ships. It is understood that definite suggestions for the building of a large ocean-going liner are being put forward by one of the leading British shipowning firms. To this end, we understand that the Clyde Navigation Trustees have been approached as to whether, if such a ship were built on the Clyde, she could be safely launched and taken to the open sea. There would seem to be little doubt as to the nature of the reply. The largest ship yet built on the Clyde is the Cunader Aquitania, which has an overall length of 901ft. 6in., and she was built in 1914 by John Brown and Co., Ltd., at Clydebank. The launching area at Clydebank is particularly good, for the yard slipways are so placed that large vessels can be launched into the mouth of the river Cart, which joins the Clyde at a point nearly opposite the Clydebank yard. The river, at this part of its course, was specially deepened by the Clyde Navigation Trustees before the launching of the Lusitania and the Aquitania, and there is no reason to believe that any insuperable difficulty would be met in the launching of a liner 1000ft. in length.

Railway Accident in New South Wales.

AMONGST the most serious railway accidents which have ever occurred in the British Empire must be placed that which befel about midnight on Monday last, September 13th, between Murrumundi and Wingen on the North-West line of New South Wales State Railways. It appears from the reports so far received that a goods train, laden with wool, was entering a siding on a gradient to let the mail train from Moree to Sydney pass, when several of the wagons broke away and rushed headlong down the hill. The mail, travelling, it is estimated, at 30 miles an hour, met the vagrant wagons in full career. So great was the speed of impact that the wagons appear to have mounted the engine, passed over it and the coach immediately behind it, and descended upon the second coach, which was full of men, women and children. The effect may be only too easily imagined. The wool was ignited, no doubt by fire scattered from the engine, and might have added to the disaster had not rescuers succeeded in keeping it away from the wreckage. It is known that twenty-six persons lost their lives at once, but as fifty were injured it is to be feared that the toll will be increased. The account of the accident is derived from cable reports, and the description of the wagons passing over the locomotive and first vehicle may require modification when an official examination has been made.

The High-pressure Turbine Steamer King George V.

No. II.*

Turbines and Gearing.

THE outstanding feature of the propelling machinery of the new Clyde turbine steamer King George V., which we illustrate in to-day's special Supplement, is that it is the first installation of its type to be built for a boiler steam pressure of 550 lb. per square inch, and a total temperature of superheated steam of 750 deg. Fah.

As will be seen from the machinery and pipe drawing given just below, a twin-screw arrangement of turbines has been adopted in conjunction with single reduction gearing. For each shaft the first and second intermediate pressure turbines are placed immediately aft of the gear case, whilst forward of it is the low-pressure turbine. In addition to these six turbines, a high-pressure turbine is fitted aft for the port shaft, and is coupled in tandem with the first intermediate pressure machine. The high-pressure turbine is designed to utilise the expansion of the steam from a stop valve pressure of 500 lb. down to a final pressure of about 200 lb. per square inch. In order to ensure that equal power is developed on the port and starboard shaft, the steam connections and turbine inlets are so dimensioned that more steam passes to the starboard than to the port turbines.

The installation is designed to develop a total of 3500 shaft horse-power when the propeller is running at its full power speed of about 570 revolutions per minute. Of this total amount, the high-pressure turbine develops approximately 550 shaft horse-power. It runs at a speed of 6000 revolutions per minute, as also do the first and second intermediate-pressure machines, while the low-pressure turbine has a normal speed of 3000 revolutions per minute. On the recent contractor's speed trials, it was shown that with full steam pressure the turbines were capable of developing more than the output they were designed for.

The single-reduction gearing is of the usual double-helical type, and the pinions of the three turbines engage with a 54in. p.c. diameter main gear wheel, the pitch circle diameter of both the intermediate-pressure pinions being 5·13in., and that of the low-pressure turbine pinion 10·26in. On the upper part of the page opposite a section through the gear case and pinion shafts is given.

The turbine arrangement which we have described possesses some distinct advantages. The choice of a special high-pressure unit for the first large range of expansion, enables short blades to be employed with correspondingly lower leakage losses over the blade tips. Again, the placing of the low-pressure unit at the forward side of the gear case allows full advantage to be taken of the increased depth at that part of the ship by the placing of the low-pressure driving pinion at the top of the main gear wheel. By this means an easy sweep of the exhaust branch from the low-pressure turbine steam outlet to the condenser inlet flange is obtained, as is illustrated by the lower drawing on the opposite page. It is true that long main steam and manœuvring connections are required with this grouping, but the steam pipe is only 4in. in internal diameter, and the manœuvring steam pipes are smaller. A large number of expansion bends are fitted to give elasticity to the pipe lines.

In to-day's Supplement we give two views of the port machinery erected in the works of the builders, the Parsons Marine Steam Turbine Company, Ltd., Wallsend, together with longitudinal sections through each of the turbines, which show the type of blading used and the arrangement of glands, thrust bearings, &c.

The first three turbines are not large in their dimensions, the overall length over governor and couplings being only about 7ft. The maximum drum diameter of the high-pressure and first intermediate-pressure turbines is about 7½in., and for the second intermediate-pressure turbine it is about 13½in., while the bearing diameters are 2¾in.–3½in. The low-pressure turbine has a maximum drum diameter of 27½in., with 5in. diameter bearings, and it contains within its casing the low-pressure astern turbine, the two-stage impulse wheel of which is formed from the solid main rotor. Three stages of reaction blading follow the impulse wheel. The high-pressure astern turbine is also of the two-stage impulse wheel type, and it is accommodated in the casing of the first intermediate-pressure turbine.

On the first three ahead turbines, which are each fitted with quite short reaction blading, an end-tightening arrangement is provided, so that liberal radial clearances may be employed, and any tendency to steam leakage be minimised by reducing the axial clearance in a longitudinal direction. The thrust block housing is furnished with a screw and lever arrangement, by which the rotor can be pulled up by the thrust block against stops. This means of adjustment maintains the necessary running clearance, notwithstanding any slight distortion caused by inequalities of temperatures when starting up and shutting down the turbines. A Michell type of thrust block is fitted on each of the turbines and the thrust on the propeller shaft is taken by a special thrust block fitted aft.

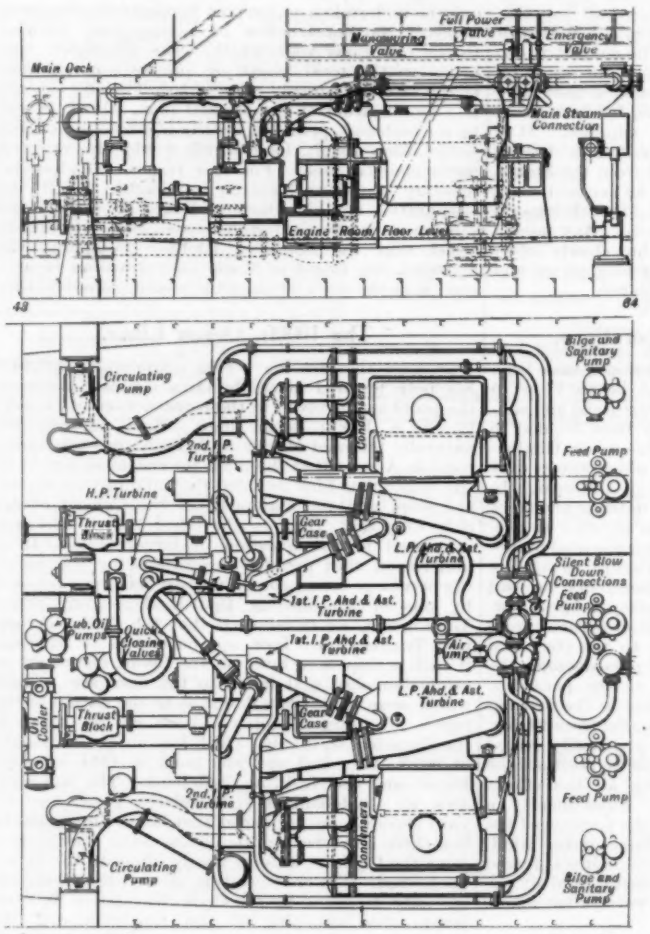
We may refer to the labyrinth type of glands which are fitted to all the turbines. These glands have an inner pocket, which is connected to some convenient point in the turbine system, so that the pressure within the inner pockets of the glands is suitably balanced. The outer parts of the glands communicate with a common pipe receiver fixed at the starting platform with a simple pressure control, so that all glands are kept at a pressure slightly above that of the atmosphere.

In view of the high temperature of the steam—750 deg. Fah.—Monel metal blading is used on the high-pressure and intermediate-pressure ahead turbines, and on the astern impulse wheel. The cylinder casings of the turbines, shown in the two photographs reproduced in to-day's Supplement, are robustly constructed in cast steel, and the same metal is used for the nozzle boxes.

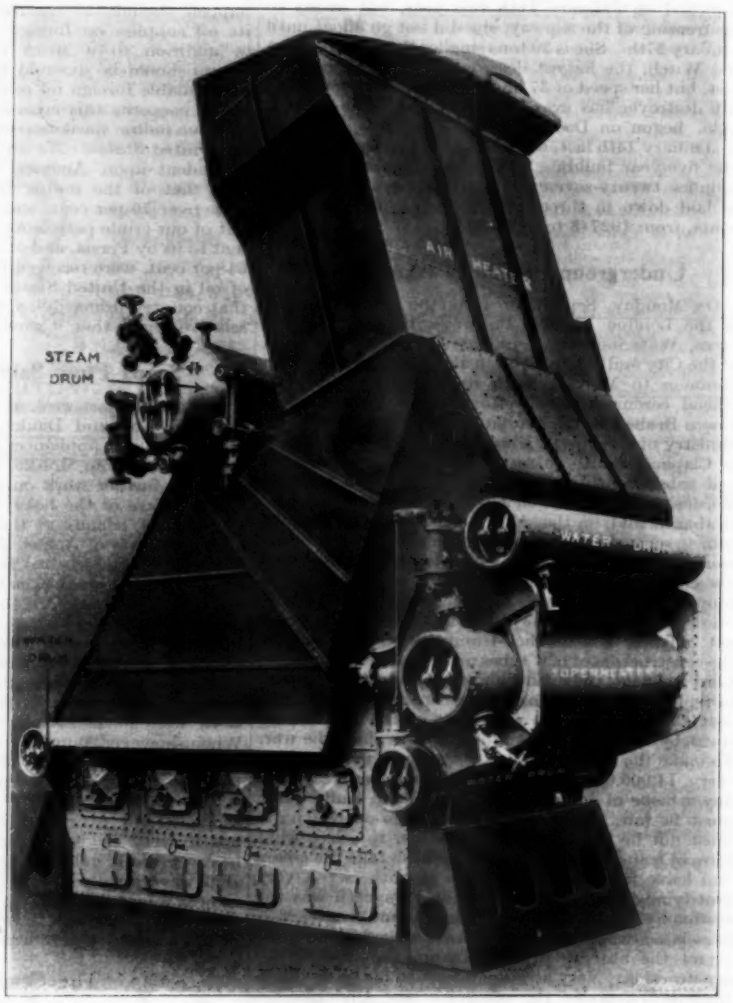
For full ahead steaming the total expansion of the steam from a stop valve pressure of 500 lb. per square inch down to a condenser vacuum of 28½in. is utilised, but for manœuvring and astern working the two shafts can be run independently of each other by steam at 200 lb. pressure. For this purpose self-closing non-return valves are fitted between the high-pressure and the first and second intermediate-pressure turbines on either shaft. The manœuvring steam pipes are furnished with nozzles so that the full pressure boiler steam is reduced to 200 lb. pressure. There are three valves at the starting platform, one full-power ahead valve and two manœuvring valves, also the silent blow controls which prevent the boiler safety valves lifting when alongside piers embarking or disembarking passengers. All turbines, except the first intermediate pressure port turbine, are fitted with an Aspinall governor for speed and emergency control, which works in conjunction with an emergency steam valve and is operated by the pressure of oil in the lubricating system. We shall refer to the design of this valve later.

Condensing Plant.

The condenser arrangement, which is shown by the lower view opposite, presents some new features. On each side of the ship there are two condensers



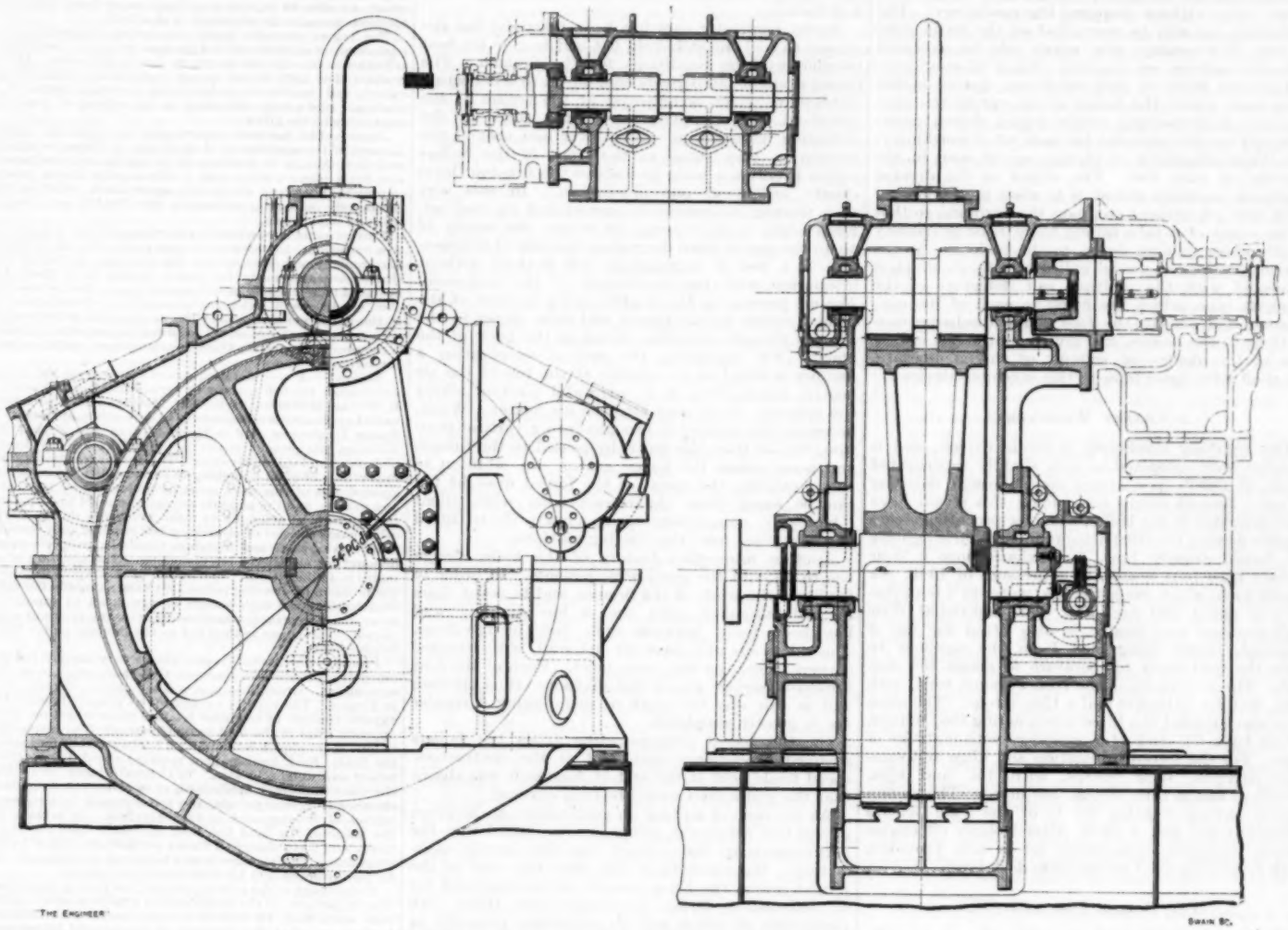
PIPE ARRANGEMENT IN ENGINE ROOM



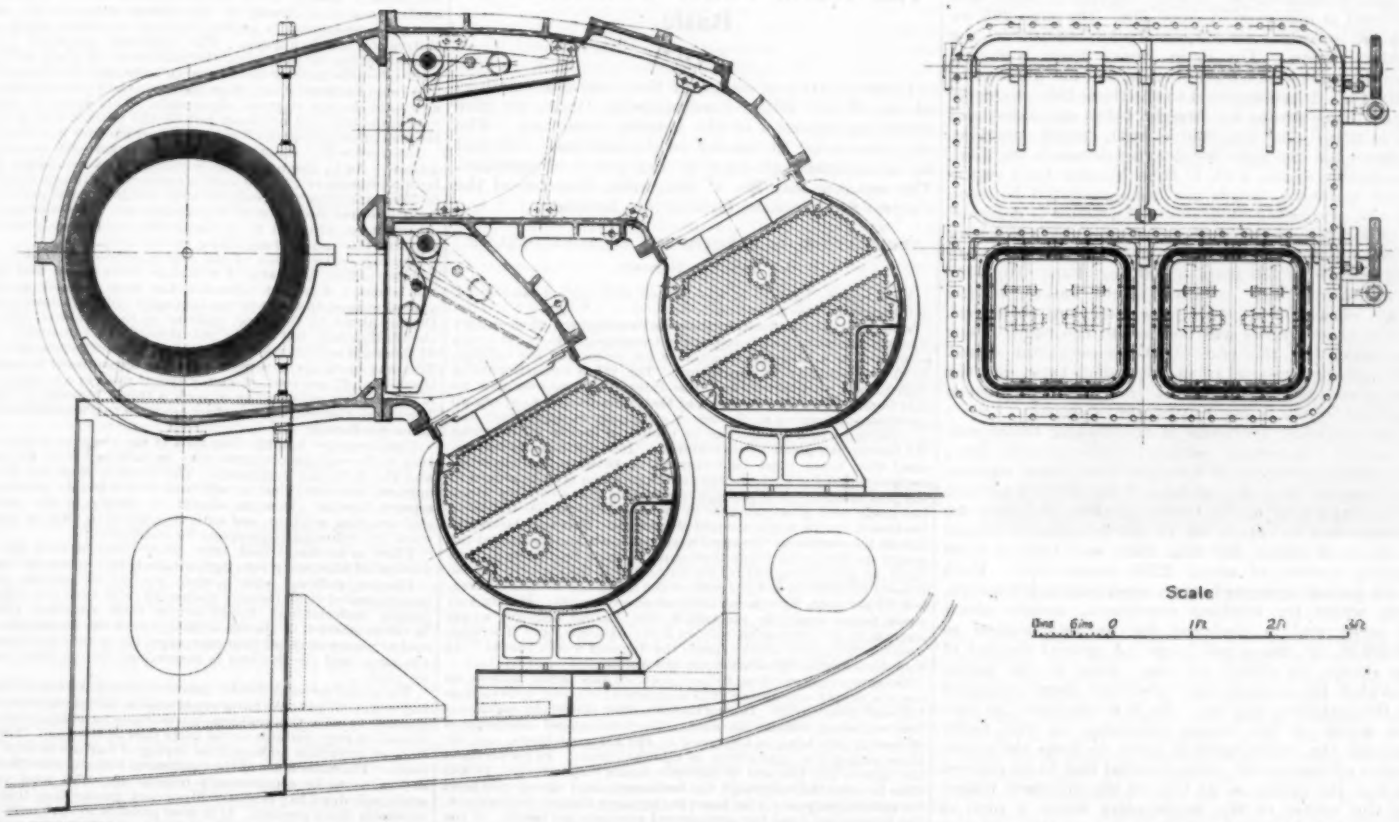
550 LB. PRESSURE YARROW WATER-TUBE BOILER

* No. I. appeared Septemb.r 10th.

THE HIGH-PRESSURE TURBINE STEAMER KING GEORGE V.



SECTIONS THROUGH REDUCTION GEARING AND GEAR CASE



ARRANGEMENT OF CONDENSERS SHOWING FLAP VALVES

which are connected to the turbines by subdivided exhaust branches. Each condenser has a diameter of 3ft. As shown in the drawing, the exhaust branches are fitted with worm-operated flap valves, enabling any one of the four condensers to be isolated from the system, and opened up for examination of the condenser tubes without stopping the machinery. The condensers can also be controlled on the water side, so that, if necessary, any repair can be executed while the turbines are running. Silent blow-off connections are fitted to each condenser, special baffles being used where the boiler steam enters the condensers. Reciprocating steam engine driven circulating pumps are provided for each set of machinery, and the arrangement of piping can be seen in the drawing on page 296. The object of the divided condenser, as above stated, is to allow one condenser to be shut off without stopping the turbines, so that in the event of a tube failing there is no possibility of salt water gaining access to the boilers. At the starting platform a special indicator is fixed, which is connected with the multiple salt detectors of the Crockatt type, which are fitted to each of the condensers, and also to the feed pump discharge connections to the boilers, and give a continuous indication of the degree of salinity of the condensate. We shall refer again later to this ingenious device.

Auxiliary Machinery.

The auxiliary machinery is steam driven, and is supplied with saturated or only slightly superheated steam at 200 lb. per square inch, through reducing valves. Special means for cooling this steam have been provided in the boiler. The reciprocating steam engines driving the circulating pumps, electric lighting set, forced draught fans, &c., exhaust into a Weir surface type feed heater, at a pressure of 15 lb. per square inch, which raises the feed water to a temperature of about 200 deg. Fah. An additional Weir high-pressure feed heater is also fitted for use if required, steam being bled from the turbines to raise the feed-water temperature to about 300 deg. Fah. The air pump is of the Weir Paragon type, with 16in. and 9in. cylinders and a 12in. stroke. The same firm also supplied the three direct-acting feed pumps, which have 6in. and 14in. cylinders with a stroke of 18in. For the forced lubrication and bilge and sanitary services, Weir pumps, with 7in. and 6½in. cylinders and a 15in. stroke, are fitted. The steam-driven electric lighting set is of the Paul-General Electric type, and a small Aster-Holmes oil engine driven emergency generating set is also provided, both sets being fixed at the main deck level.

The Boiler Installation.

The two mercantile marine type boilers for the King George were designed and built by Yarrow and Co., Ltd., of Scotstoun, Glasgow, and the design, while not unlike that used in the Navy, follows closely that which has been lately used by the firm for several successful power station plants. The boilers were described by Mr. Harold Yarrow in a paper on "High-pressure Water-tube Boilers for Marine Purposes," which was read at the last Spring Meetings of the Institution of Naval Architects, and was reprinted in our issue of April 9th. On page 296 we give an outside view of one boiler erected in the builders' shops. The main steam drum is forged from the solid with closed in ends, and has a diameter of 3ft. 6in. It is connected to the three 18in. diameter forged water drums by straight tubes expanded and bell-mouthed in accordance with usual practice. Between the two right-hand water drums is the 23in. superheater drum, with U tube Yarrow type superheater elements, which are accommodated between the two generating elements. The boiler is designed to supply steam to the engine-room at a working pressure of 550 lb. per square inch, and a total steam temperature of 750 deg. to 800 deg. Fah. High-lift Cockburn-MacNicol patented safety valves, to the design of which we shall refer later, are employed. One of these valves will be seen to the right of our illustration on the end of the superheater drum. The water gauges are of the Dewrance type, and the feed-water regulators are of the Anthony pattern supplied by the Aster Engineering Company, Ltd.

The following are some of the leading boiler particulars:—Generating surface, 2550 square feet; superheating surface, 870 square feet; total surface, 3420 square feet. Air heaters of the Yarrow pattern are incorporated in the boiler uptakes, and they are dimensioned to supply air to the furnaces at a temperature of about 500 deg. Fah. and have a total heating surface of about 2200 square feet. Each boiler including its air heater, superheater, brickwork, with water for working conditions, weighs about 40 tons, and is designed for an evaporation of 20,000 lb. of steam per hour. A special feature of the design to which we may refer is the means provided for cooling the saturated steam supplied to the auxiliary engines. As it is necessary to pass the whole of the steam generated by the boiler through the superheater in order to keep the superheater elements cool, some method had to be devised to cool the steam on its way to the auxiliary mains. In the centre of the superheater drum a pipe of narrow bore is fitted, which passes up the centre of the main connecting pipe between the steam drum and the superheater and into the water space in the top steam drum. At this part of its path this pipe is equipped with a series of metal gills which materially assist in cooling the superheated steam down to the temperature of the water in the drum. This device is probably one of the most ingenious of the many interesting contrivances in the boiler and machinery installation.

Again, particular care has been taken by the designers to cool the stokehold flat and to give the best possible working conditions for the firemen. The forced draught fan delivers cool air on to a deflecting diaphragm, which is arranged at the centre of the stokehold. In "spilling" over the edges of the deflecting plate the air passes over and around the firemen as they stand at the front of the boilers before it enters a hood just above the fire-door level clearly visible in our illustration. In this way each fireman is continually surrounded by cool air. Even when it is necessary to reduce the supply of air to the grates when decreasing the rate of evaporation as a pier is approached, this is done without interfering with the ventilation of the stokehold. The air passing up the double casing in front of the boilers, enters the air heater and then passes to the ash pit through a double casing at the back of the boiler. For regulating the rate of evaporation a damper is fitted in the uptake at the top of the air heater, which when in a horizontal position allows the entering air to pass into the air heater. When, however, the damper is brought into a vertical position, the air from the fan is by-passed to the funnel, and none enters the boiler grates. In addition to this provision, the speed of the forced draught fan can be eased from the engine-room, while silent "blow-off" connections are as already stated fitted and controlled from the starting platform.

Another interesting feature of the boiler design has to do with the grate arrangements. In order to facilitate the work of the firemen and to assist them in maintaining a solid fire, a low dividing wall has been built between each pair of fire-doors. The side walls also have an end wall, with rounded corners where the two walls meet. Each of the four fire-doors serves one of the divisions thus created, and in this way the work of maintaining a regular fire is greatly simplified.

On the recent demonstration trials the boilers steamed exceedingly well, and at the contractors' speed trials held at the end of August it was shown that the guarantees would be fully covered.

At the time of writing no particulars can be given of the fuel consumed, but it can be stated that the performance in this respect was also highly satisfactory. We understand that after the close of the tourist season the King George will be chartered for an exhaustive series of consumption trials, full particulars of which will be published, probably in a paper which will be read before one of the senior institutions. In the third—concluding—article we shall deal with the special requirements of the steam pipe lines and auxiliary fittings and valves.

The World Power Conference at Basle.

No. II.*

CONTINUING our report of the sectional meetings of the World Power Conference at Basle, we give below an abstract of the general report on "The Application of Electricity to Agriculture," followed by a summary of some of the principal speeches. The reporter was Mr. F. Ringwald, Director of the Central Sweitzerische Kraftwerke, Lucerne.

APPLICATION OF ELECTRICITY TO AGRICULTURE.

General Report.

Nine reports have been received on this subject, and a few points may be taken from each.

America.—The realisation that the employment of electricity was insufficient to justify expensive transmission lines led to the formation of a National Committee for promoting the employment of electricity in agriculture. The State Departments of Agriculture, Commerce, and the Interior are represented on this Committee. The business of the Committee is to study all questions pertaining to the use of electricity in agriculture and to determine how its use can be promoted and to what extent the farmer can profit by its adoption. It is particularly emphasised that there must be co-operation between the electrical engineers and the agriculturists if the problem is to be solved in the best manner. It is perhaps remarkable that a country which has made such great progress in technical matters should be so backward in this application of electricity. This may be largely due to the enormous distances which separate the farms and the power stations from which their supplies must be obtained; but there are good prospects for the extension of the supply. At the present time about 7·8 per cent. of the farms use electric current, but 47 per cent. have some other source of power. If only half these farms could be electrified, the annual demand would amount to 3·5 thousand million kilowatt-hours, and if it were possible to include all the farms the demand would rise to 7·54 thousand million kilowatt-hours per annum.

Germany.—More than 90 per cent. of the farms possess an electric supply and during 1925 accounted for about 1030 million kilowatt-hours in all. During the threshing period the maximum load was about 400,000 kilowatts. The total annual consumption of energy per head in Germany is 180 kilowatt-hours, and for those engaged in agriculture 50 kilowatt-hours. In Switzerland the figures are 450 and 50 kilowatt-hours respectively. It will thus be seen that although the consumption of energy per head for general purposes is far lower in Germany than in Switzerland, the figures per head for agricultural purposes are equal. If the consumption is calculated per hectare, however, that in Germany is seen to be considerably greater. The chief part is played by the cultivation of grain, which requires a considerable amount of power. The authors of the German report calculate that the agricultural demand for the next decade will amount to some three to four thousand million kilowatt-hours per annum. Curiously enough the load from domestic heaters, hot water storage boilers, potato boilers, and silage plants is of far less importance than the motor load. As it is just these applications which are able to provide a welcome night load, there is room for more intensive development in this field.

The report contains many interesting suggestions on the equipment of agricultural distribution systems. Secondary distribution is usually carried out at 220 or 380 volts. It is fully realised that agricultural supply equipment should be cheap, robust, and capable of withstanding a certain degree of overloading. Interesting reflections on the subject of power factor improvement are given.

Japan.—The Japanese reports give an extremely interesting account of the application of electricity to Japanese agriculture and show that, as in America, the irrigation and drainage of the rice fields plays a large part. Electrically driven pumps for improving poor land are greatly appreciated, which in view of the rapidly increasing population (600–700,000 per annum) is a point of importance.

Furthermore, rice, which is the principal food, requires extensive irrigation. In order to cheapen production on the farms the Government makes grants for the purchase of electric motors. Grants are also made for petrol motors since these can be operated more cheaply at the present time. On the whole, however, conditions in Japan are favourable to electrification owing to the dense population and the existence of an extensive distribution network. Most of the power for irrigation and drainage is required in summer. There is extensive co-operation amongst the farmers.

England.—A very detailed report comes from the pen of the well-known English pioneer in agricultural electrification. Mr. R. Borlase Matthews. While Mr. Matthews dealt with the most varied applications of electricity to agriculture at the last World Power Conference and subsequently in his journal *Electro-Farming*, his present report is limited exclusively to electric ploughing and soil cultivation. The author recognises the great importance of good ploughing in successful cultivation. As the greater part of this work must be performed by men, animals, and motors, and the animals consume from 24 to 67 per cent. of the product, he attempts to make electricity do the work. In other cases the use of electricity has resulted in a considerable reduction of costs and therefore there are prospects of a great demand for electricity for ploughing. The question of supply mains is a difficult one. The author of this report usually solves the problem by erecting permanent lines alongside the fields and transforming the high-tension energy down to supply voltage by means of a portable transformer car having a current-collecting device. The power is then led to the haulage motor through a flexible cable.

France.—The French report shows very clearly the growing recognition of the great services that electricity can perform for agriculture. Great attention is being paid to electric ploughing in France. The type of equipment at present favoured by the experts consists of two rope haulage gears which are placed on opposite sides of the field to be ploughed. The reversible three or four-share plough is then drawn backwards and forwards across the field. Each haulage gear requires about 100 to 150 horse-power and weighs 15 tons. In Central France, as in America, the most important application of electricity is irrigation using electrically driven pumps, and there appear to be great possibilities of development in this direction. In certain districts the value of the land has been increased from nothing up to thirty and forty thousand francs per hectare simply by suitable irrigation. The average power required per litre-sec. and per hectare is about 100 kilowatt-hours per annum.

With regard to the econmic aspect, the French report mentions that 42 per cent. of the entire area of France is under cultivation, that more than 10 million hectares await electrification, and furthermore that the shortage of agricultural labour promises a great future for a rational application of electricity.

With farms fairly widely separated as they are in France, the problem of electrification becomes rather financial than technical. The State has given considerable assistance during recent years, first by grants à *fonds perdu* to rural associations and farmers, and secondly by long-period loans at a maximum interest of 3 per cent. In 1923 the Parliament voted 600 million francs for this purpose. In many cases the departmental and local authorities are assisting by loans or by covering working deficits.

Switzerland.—The main impression left by the report is that Switzerland already leads other countries in the diversity of applications of electricity to agriculture, although the specific energy consumption is greater in those countries where grain cultivation predominates. The measures proposed by the Confederation for promoting the cultivation of grain will effect a considerable increase in the energy consumed for this purpose. The Swiss Farmers' Association possess in the Trieur Laboratories an establishment of great importance. This Institute tests all new apparatus and processes put on the market and gives the farmers information on all subjects in which they are interested.

Denmark.—The report is chiefly concerned with supply conditions. As in Germany and Switzerland, a secondary distribution pressure of 220/380 volts is preferred. Climate conditions in Denmark usually necessitate large insulators and particularly good internal insulation of the equipment. The working conditions have also led to a discontinuance of the practice of earthing the frames of apparatus or machines.

Norway.—The author of the report points out that Norway has ten million kilowatts of available water power and that of this about 1·4 million kilowatts has been utilised, giving an annual output of about seven thousand million kilowatt-hours. Of this about 5½ thousand millions go to the electro-chemical, electro-thermal, and timber industries; the remainder, about 1½ thousand million kilowatt-hours, serves for the general supply. This has made great progress even in agricultural districts, so that about 57 per cent. of such districts possess a supply, which is particularly noteworthy in such a thinly populated country. The average annual consumption amounts to about 450 kilowatt-hours per farmer.

Conclusions.—A fairly clear idea of the progress of electrification in the various countries may be obtained from the reports and the foregoing comments. The General Reporter is of the opinion, however, that in addition to the points raised in the reports, special attention should be drawn to the problems still awaiting solution, and with this object in view he puts forward the following suggestions for discussion:—

There is no doubt that from every point of view the introduction of electricity into agriculture brings economic benefits.

Electric milking with modern equipment can be warmly recommended to all farmers possessing more than ten milk cows. Supply undertakings should devote their attention primarily to the promotion of electric milking, since the energy for this is sold at power rates without increasing the maximum demand of the farm, and the demand is maintained during 1000 hours in the year.

The preservation of fodder must continue to be one of the most important subjects claiming our attention, and it ought soon to be possible to solve this problem, particularly in districts where the climate is very variable in the early part of the year. The questions of wet silage and artificial drying of hay are of first importance. The efficiencies of the equipment hitherto used have been so low as to be economically impossible. The food value of artificially dried hay is nearly 20 per cent. greater than that of the naturally dried product. If it were possible to save only a third of the hay crop in Switzerland from rot by adopting artificial drying, the monetary saving in remedial means would be about thirty million francs.

* No. I. appeared September 10th.

The subject of electro-culture is one which requires clearing up as soon as possible. A careful study of the results obtained in the different countries shows that none are sufficiently consistent to be of use in deciding on the best system. In England the use of high-tension direct current which is applied to a wire network suspended over the plants and passes into the ground through the intervening air appears to have attained a certain degree of success, and it seems as though the English climate (damp and salt-laden air) is particularly favourable for this system (see the publications by Professor Blackmann of the Botanical Institute, in London). From the French report it would appear that high-frequency currents were of more utility than high-tension direct current, whereas the tests carried out in Germany and Switzerland have given absolutely negative results. No better conclusion is to be drawn from the use of the Christofleau system using atmospheric electricity. On the contrary, the exposure of plants to ordinary electric light in nurseries has given most remarkable results. The use of electric lighting in fields has not produced anything like the same apparent advantage.

Electric traction on the land as a substitute for horses and petrol tractors should also be made a subject for discussion.

Accident prevention demands careful attention.

General.—In order to further the above questions the formation of study committees in the various countries is indicated. If necessary an international committee should be created in order to promote the exchange of ideas between countries. We must remember that it is necessary that a large amount of capital should be invested in agriculture and that the present application of electricity in this field does not represent a very favourable load. Every fresh application improves the conditions, however.

There is no doubt that electricity is capable of rendering far greater services to mankind than appears to be the case to-day. The favourable progress of electrification depends, however, on close co-operation between investigators, farmers, supply undertakings, and economists.

Section D met for the first time to discuss this question on Thursday afternoon, September 2nd, under the presidency of Mr. A. R. Angelo. Four papers, presented respectively by Mr. Borlase Matthews, Rung and Faaborg-Anderson, Norberg-Schulz, and White, were submitted for discussion. Mr. F. Ringwald, the reporter, addressed the meeting in German, summarising the progress made in various countries with respect to the use of electrical power for farming purposes. Mr. Borlase Matthews, whose advocacy of electrical methods of agriculture in England is so well known, opened the discussion. He said that he had chosen the subject of electric ploughing for his paper because it was most attractive from the point of view of the electrical engineer, whose difficulty was to find enough demand for power on a farm to make a supply profitable. If farmers were only properly instructed and were provided with proper appliances, they could furnish a load for central stations which in the aggregate would exceed the industrial load in practically every country of the world. British farmers at present were passing through extremely difficult times, and their only hope seemed to be to reduce the costs of operation by the help of the engineer.

Mr. Stewart, representing the National Committee for the Relation of Electricity to Agriculture in the United States, said that the General Reporter had considered it remarkable that America should be so backward in the application of electricity to farming purposes. It would therefore be well to explain the situation a little fully. According to the survey of world power in the *Electrical World* of January 9th, 1926, the forty-three countries which supplied information produced 101,406,485,777 kilowatt-hours of electricity in 1925. The figures for Germany were not included, but data before the Conference showed that Germany produced about 11,400,000,000 kilowatt-hours. The total for the forty-four countries was thus 112,806,485,777 kilowatt-hours, of which the United States produced 54,418,403,000 kilowatt-hours, or almost one-half of the total. The population of forty-four countries is given as 637,527,000, of which the United States had 112,684,000. In other words, less than 18 per cent. of the total population, living in the United States, were using more than 48 per cent. of the total energy generated. There were in the United States about 180,000 farms taking electric power from power companies, and about 250,000 farmers had private plants. These 430,000 farms represented, however, only 7 per cent. of the total farms in the United States. The 180,000 farms which were supplied by power lines were using about 420,000,000 kilowatt-hours per annum, so that the energy consumption per farm was around 2300 kilowatt-hours per annum. The study of the utilisation of energy in agriculture was started in Minnesota in 1920, and in 1923 a State Committee was formed and a field laboratory inaugurated. Since then twenty states had organised experimental farms under the direction of the National Committee on the Relation of Electricity to Agriculture. More than 250,000 dollars had been spent on investigations, and the directors of the various projects met annually to secure co-operation. The intensity of effort and study now being devoted to the application of electricity to agriculture in the United States was very great, and the work was being carried on with the fullest co-operation of colleges and universities. As regarded tariffs or rates, the rate in use at Redwing, Minnesota, was representative of the kind of rate recommended. It consisted of a fixed charge of 6·90 dollars per month per customer, plus a charge of 5 cents per kilowatt-hour for the first 30 kilowatt-hours and of 3 cents per kilowatt-hour for all energy used per month in excess of 30 kilowatt-hours. That rate was based on the complete financing of the primary and secondary power lines by the power company. That type of rate would be used uniformly throughout Minnesota. In California, where large hydro plants made electrical energy cheaper, the farmers were getting electricity at about half the cost mentioned.

Energy was supplied to the farms by three-wire alternating current at 220 or 110 volts. All motors of half horse-power or over were connected to the 220-volt service. The large motors for thrashing, ensilage cutting, irrigation, &c., were supplied at 440 volts through portable or separate transformers. The transformers to supply the low-tension farm service were now placed in the farmyards, so as to secure short secondaries. The primary service was at 2200 volts, where the maximum load per line was not more than 125 kilowatt-miles. On more heavily loaded lines 6600 volts was becoming standardised. There was some three-phase farm service, but most new lines were single phase, as costs do not warrant three-phase construction. Lines from 8 to 16 miles long were being built to give farm service. Among the uses of electricity might be mentioned the drying of hay. There were two instances of large hay drying plants, in which alfalfa was dried and ready for storage within thirty-five minutes of being cut. Messrs. Ekstrom, Wallem, Friedrich Brock and Ringwald also took part in the discussion.

The section resumed its sitting at 9.30 a.m. on Friday morning under the presidency of Dr. M. Kano.

Monsieur Bitouzot remarked that, with regard to the alleged excessive cost of drying hay artificially, all prices were relative. In a dry year it might well be that the sun would do the work more economically, but when the weather was bad the farmer was faced with the choice between making bad hay naturally or good hay artificially. In France that year the use of electricity in agriculture had been put in one respect on a commercial basis. A company had been formed to operate electric winding gear and ploughs in the neighbourhood of Paris, the idea being to offer the farmers to take a contract at so much an acre to do their ploughing electrically. There were many prophets of evil, who prophesied that at the prices asked—250f. to 500f. a hectare—there would be no demand for the services of the company. However, two or three days ago the speaker had seen seven electric apparatuses in full action at seven different places north of Paris. Of those sets, three would plough at least 500 hectares, and the company during its first year of existence would cultivate between 2500 and 3000 hectares of land.

Dr. M. Kano said that in Japan the introduction of electricity into the rice fields was proceeding very rapidly, but in view of the increase in population from 600,000 to 700,000 annually, it was necessary to convert marshy and desert land into rice fields by means of drainage and irrigation, if the population was to be fed. For such work there could be used from 400,000 to 500,000 horse-power. Much was being done to improve agriculture in Corea, where ten years ago no rice at all was grown. Power for the farmers was generally produced by oil or suction gas engines on the individual farms, but there was an abundance of anthracite and lignite coal which, the speaker hoped, within a few years would be used to produce electricity in central stations. In Japan brilliant electric lights were used to attract moths in the rice fields, the moths falling into pans of water underneath, thousands being killed every night. The moths themselves were harmless, but the caterpillars which developed from their eggs did enormous damage in the rice fields.

Mr. Velander explained the system of rural distribution of electricity used in Sweden. The energy was distributed in each district at about 3000 volts. From the State system about 40 per cent. of the cultivated area was electrified, while 16 per cent. was electrified by private enterprise. The State system of charging was as follows :—First a fixed annual charge of 3·5 gold francs per hectare of tilled soil, then another fixed charge of 350 gold francs per kilowatt of energy demanded, and in addition to these a rate of 9·7 centimes per kilowatt-hour. In the area of the South Swedish Company the Consumers' Co-operative Society themselves buy the distributing lines and turn them over to the company to operate. They pay interest on their own capital at the rate of 8 per cent., and in addition they pay 4 per cent. to the company for attendance, maintenance and operation. The energy is sold at the rate of 11·1 centimes per kilowatt-hour, and the Society decided the rate its members pay individually. The system was a good one and led to a development. The average consumption of electricity in Sweden at present was 44 kilowatt-hours per hectare per annum and the rate of increase was 7 per cent.

A further meeting of this section was held in the afternoon, members reassembling under the presidency of Dr. Kano at 2. p.m.

Mr. Kitson mentioned many possible uses for electric heat in agriculture, for the drying of tea leaves, copra, grain, cocoa nibs, &c. He also suggested that the ultra-violet light might be useful as a substitute for the spraying of the trees in rubber plantations. Ultra-violet light had been found very beneficial in destroying vegetable and insect parasites and its uses in those respects had not yet been fully exploited.

Mr. Stewart said that it had been discovered in America that the treatment of food by ultra-violet light had the same effect on the animal fed as treating the latter directly. Applying ultra-violet light to cattle food had resulted in the production of milk with a higher vitamine D content, and hens treated by the light produced eggs with five to seven times the vitamine D content of ordinary eggs. The question of tariffs was very important. The fundamental principles of tariffs should apply to every place and country in the world. It was easy to frame a bad tariff. In America one company had a tariff which increased its consumption from about 400 kilowatts per farm to 1800 kilowatts, with 2000 consumers on the lines. That company recently found that it was losing about 8000 dollars a month owing to the inadequate type of rate. Some rates tended to keep down the consumption of electricity, whereas what was wanted was to increase it. On one European system there were 4000 farms, of which 2400 had less than twelve lights. Figures for 1400 farms in America showed an average of nineteen lights per farm, and in Canada they showed twenty-nine lights per farm, because there the rates were not based on the number of lights.

Mr. Kettle said that both in Ireland and in England the farmer had not yet been interested in the supply of electricity to farms. The supply engineers had come to the general conclusion that electricity could only be supplied to the average farmer at a loss, either to the farmer or to the company, depending on what kind of price was charged. It was interesting to find that in Switzerland 50 million units per annum were used by farmers. Swiss farmers certainly were good enough business men only to take electricity if it paid them to do so, and what the speaker wanted to know was whether the supply authorities were equally satisfied.

Mr. Borlase Matthews said that a National Poultry and Husbandry Institute had recently been founded in England, and tests would be carried out this winter on the application of electric lighting and heating to hen-houses. Agricultural electric motors had reached a certain stage of perfection, but more must be done to make them proof against dust, artificial manure, ammonia gases from stables, and so on. A standardised and robust form of speed reduction gear should also be supplied, and agricultural machinery should be arranged to be driven at higher speeds than at present. As to artificial haymaking, that was really a bacteriological process, for an electric fan could "cure" 30 tons of hay working only for a half-hour or an hour per day for nine days, which would obviously be insufficient for real drying of such a quantity. The Oxford School of Agricultural Engineering had done some good work in connection with the drying of sugar beet. The beet could be sliced, dried and stored, so that the sugar factory could be kept operating throughout the year. With regard to milking machines, the speaker had some sympathy with the farmers' reluctance to let people experiment on his cows. As a practical farmer himself he knew that a cow was a sensitive creature and could easily suffer damage.

Following a short discussion on the subject, it was moved by Mr. Stewart that the acting chairman, Dr. Kano, be instructed to refer to the Executive Council of the World Power Conference the desire of the section to have an International Committee appointed to study the application of electricity to agriculture.

Models and Analogies for Demonstrating Electrical Principles.

No. VI.*

MANY models have been devised for explaining wireless principles, which in these days interest a considerable number of people. The valve characteristic model—illustrated in Fig. 45—was designed

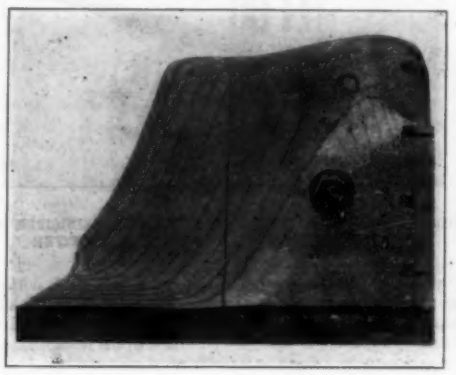


FIG. 45—VALVE CHARACTERISTIC MODEL

by Professor C. L. Fortescue for demonstration purposes at the Royal Naval College, Greenwich. It shows the relationships existing between three independent variables of a thermionic valve, viz., grid voltage, anode voltage and anode current. Grid voltage is plotted horizontally along the front of the model as illustrated, the centre point being chosen to represent zero grid potential. Anode voltage is plotted horizontally from front to back, zero being at the front. Anode current is plotted vertically

* No. V. appeared September 10th.

from zero at the base to saturation at the top of the model. The model is built up in sections, the boundaries of each section in vertical planes parallel to the front of the model being anode current—grid voltage curves at constant anode potential. An example of a constant grid potential curve is shown drawn through zero grid voltage. Other such curves can be drawn in planes parallel to this one. If horizontal lines or "contours" were drawn they would show the variation of anode voltage with grid voltage at constant anode current. Assuming all these lines drawn, it follows that the constant current curves would appear in a projection of the model in a horizontal plane; the constant anode voltage curves in a projection in a vertical plane in front of the model; and the constant grid voltage curves in a projection in a vertical plane at the side of the model. As these two-dimensional curves are usually more familiar to students it has been found useful to build of wire a skeleton replica of the model, and to project it in the

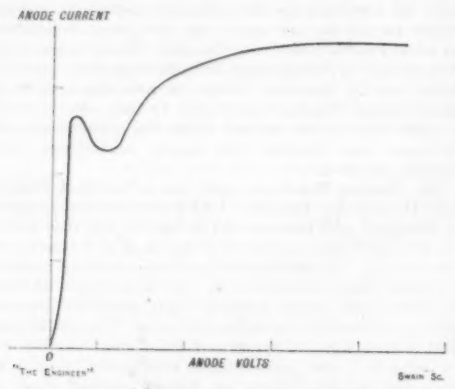


FIG. 46—ANODE VOLTAGE—ANODE CURRENT CURVE

three planes mentioned upon a ground glass screen by means of a parallel beam of light.

An interesting feature of the model is the formation shown at the front on the right of Fig. 45. This is shown more clearly in Fig. 46, which is a side view of the model and consequently a constant grid voltage curve. In this region the grid voltage is highly positive. Owing to the heavy electronic bombardment of the grid there is a considerable secondary emission; and as the anode voltage is raised from zero, the rapid growth in anode current is chiefly due to this cause, a large part of the anode current actually passing through the grid circuit. As the anode voltage increases and more electrons miss the grid, the secondary emission decreases, and in this particular region the anode current is seen to fall off. A sufficient increase of anode voltage must of course eventually raise the anode current to a value very near to saturation. The small dip in the curve shown is the beginning of a

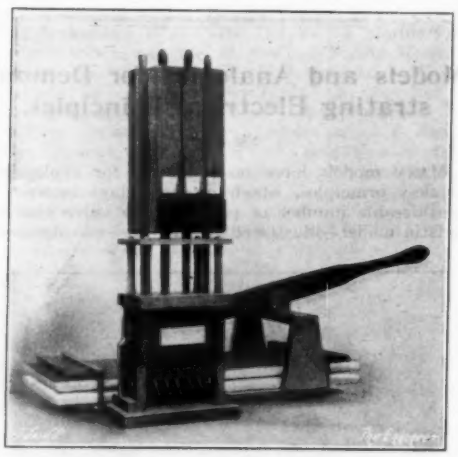


FIG. 47—MODEL FOR DEMONSTRATING THE PRINCIPLE OF A SUPER-HETERODYNE WIRELESS RECEIVER

"valley" in the model, which deepens and widens as the grid voltage is made more positive. The model has been found especially useful in lecturing on valve oscillators, as it is possible to trace upon it oscillation lines corresponding to various conditions.

Mr. A. E. Bowyer-Lowe, of the Bowyer-Lowe Company, Ltd., of Letchworth, uses the model shown in Fig. 47 for demonstrating beat notes in connection with super heterodyne wireless receivers. It consists of six organ pipes, normally of the same pitch. Two of the pipes are exactly tuned together, two are slightly sharp by varying amounts, whilst the remaining two are flat by varying amounts. If the two true pipes are sounded singly or together only one tone is heard, but if one of the true pipes be sounded together with one of the pipes that is slightly flat a third note is heard sounding like an increase and decrease of the volume of sound. This is the beat note which is slow, because the difference in pitch is very slight, but if the pipe be sounded that is still more flat, a beat note is produced that is more rapid than the first one. Similarly if the true pipe be sounded together with the one that is slightly sharp a slow beat note is again heard, whilst if the pipe is sounded which is more sharp together with the true pipe a more rapid beat note is again heard. If the ears could be trained to ignore the two fundamental notes and only take

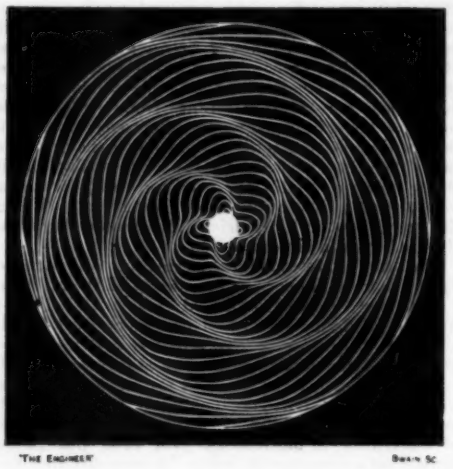


FIG. 48—BOTTOM PART OF LANTERN SLIDE

notice of the two beat notes, the performance of the super heterodyne receiver could be faithfully reproduced. The beat note could be so increased in rate as to become a new musical note.

In the super-heterodyne wireless receiver there are two frequencies which are mixed to produce a third

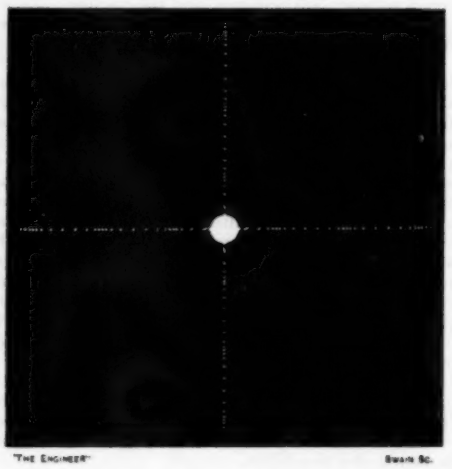


FIG. 49—TOP PART OF LANTERN SLIDE

frequency, which is equivalent to changing the wave length. There is the incoming frequency corresponding to the wave length of the transmitting station, and another frequency produced by an oscillating valve in the receiver, the resulting frequency usually being lower than either. If, for instance, speech or

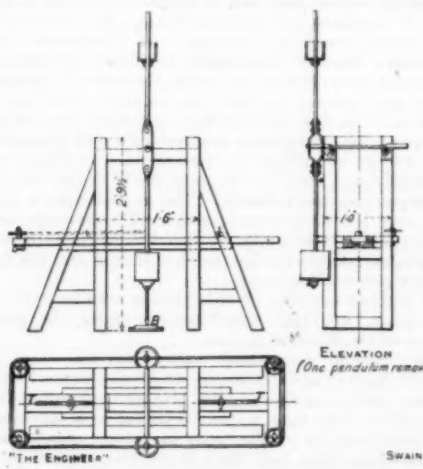


FIG. 50—MODEL FOR DEMONSTRATING THE EFFECTS OBTAINED IN COUPLED CIRCUITS

music is being received from "2 LO" on a wave length of 365 m., corresponding to a frequency of 820,000 per second and a wave length of 310 m., or a frequency of 970,000 be superimposed on the former, the beat frequency would be the difference, *i.e.*, 150,000 per second, which is equivalent of 2000 m. The same beat note could be obtained by superimposing a wave length of 450 m., or a frequency of 670,000 per second, because the difference is still 150,000 per second.

For illustrating longitudinal wave motion, Mr. Philip Kemp, of the Regent-street Polytechnic, uses a lantern model—as shown in Figs. 48 and 49. The model consists of a glass slide on which the diagram—shown in Fig. 48—is drawn, the lines being clear, whilst the remainder of the plate is black. Above this another glass slide—as shown in Fig. 49—is mounted, this slide being completely black, except for two straight lines at right angles to each other, and only that part of the under slide shows which is directly underneath the clear lines of the upper glass. Both the slides are circular, and the former is provided with a rack at its rim, which engages with a small pinion driven by a handle. On turning this the diagram—shown in Fig. 48—is slowly rotated, and the series of dots which shows through appears to move backwards and forwards, thereby indicating the wave it is desired to represent; the appearance of the diagram, which can be thrown on the screen, being shown in Fig. 49.

A model designed by Dr. E. W. Marchant for demonstrating some of the effects obtained in coupled

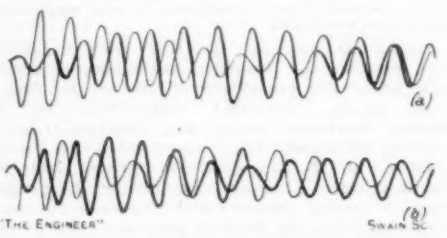


FIG. 51—CURVES SHOWING THE EFFECT OF TIGHTENING THE COUPLING OF CIRCUITS

oscillating electrical circuits was described in the *Electrician* of September 28th, 1913. In this model the primary and secondary circuits are represented by two oscillating pendulums, arranged as shown in Fig. 50, and the top and bottom weights of these pendulums can be moved along the rod to enable them to be adjusted to oscillate with identical periods of swing or with any desired difference in period. The pendulums are coupled by connecting them by rubber cords of varying thickness, the coupling cords passing round light aluminium pulleys, which are supported on T frames to enable the tension in the bands to be adjusted. The object of this arrangement of pendulums and coupling-rods is to bring the two oscillating pendulums into line and to give a symmetrical control to each pendulum.

Each pendulum is attached to a brush, which is supplied with ink from a tube, and the markers move over a strip of paper fastened to a flat board, which

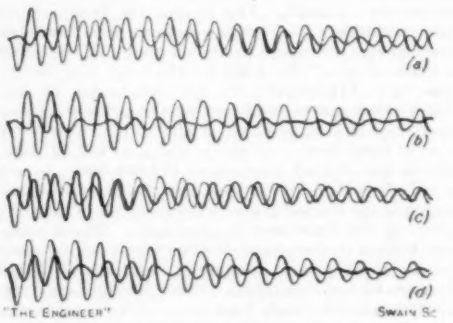


FIG. 52—TUNED AND UNTUNED PENDULUM CURVES

is driven steadily along a slide by an electric motor. The two brushes are arranged as close together as possible, so that the oscillations of the pendulums can be compared both in phase and in amplitude. Different coloured inks are used for the two brushes, so that the traces may be distinguished from each other. The displacement of the pendulum represents pressure difference across the condenser of the oscillating circuit, and the current flowing corresponds with the velocity of motion of the pendulums. Since maximum current and maximum potential difference are proportional to each other, the amplitude of the curves may be taken to represent the magnitude of either current or potential difference in the oscillating circuit, though the two quantities are 90 deg. out of phase with each other.

When one of the pendulums is set in motion its energy is gradually transferred through the rubber band to the other pendulum, and the stronger the band—*i.e.*, the tighter the coupling—the more rapidly is the energy transferred—as illustrated in Fig. 51. Here the resultant oscillation shown really consists of two oscillations of slightly different frequencies. When the two component oscillations are in the same direction the resultant is large, whilst when they are out of phase it is small. The difference in frequency of the components may therefore be estimated from the curves showing the resultant oscillation, there being

a difference of one complete oscillation in the two component oscillations between two minima in the resultant curve. The curves *a* and *b*—Fig. 51—show that the difference in frequency of the components is increased with increase in the tightness of the coupling, which corresponds with the well-known phenomenon that the difference in wave length of two waves from a coupled oscillator increases with the tightness of the coupling between the circuits.

The model may also be used for showing the necessity for accurate tuning between circuits when loose coupling is employed. In Fig. 52 two sets of

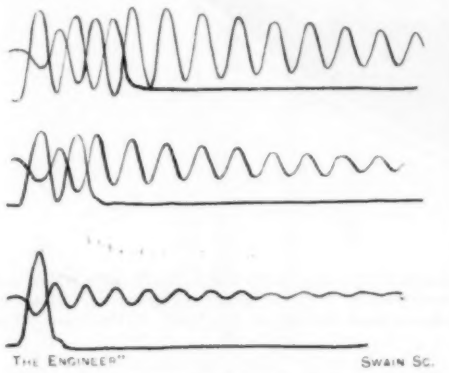


FIG. 53—CURVES SHOWING INCREASED VIBRATION DUE TO TUNING

curves are shown, one set relating to "tuned" pendulums and the other to pendulums with a difference in the natural period of 20 per cent., the pendulums being loosely coupled. In Fig. 52A, where the pendulums are "tuned," the resultant oscillation of the second pendulum is much greater than in Fig. 52B, where the pendulums are not adjusted to the same period. The greatness of the difference between the resultant maximum oscillation of the second pendulum in the two cases depends on the tightness of the coupling, and this is also shown in Fig. 52. Figs. 52C and 52D show the resultant oscillations for the same primary impulse with tight

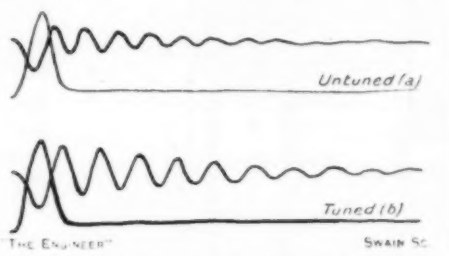


FIG. 54—CURVES SHOWING INCREASED OSCILLATIONS WITH TIGHT COUPLING

coupling. Fig. 52C gives the resultant oscillations when the pendulums are tuned, and Fig. 52D when there is a difference in the natural period of 20 per cent.

The model may be employed to show the effects of shock excitation, such as is used with a quenched spark. If the pendulum corresponding to the first circuit be drawn aside and the second pendulum be allowed to come to its new position of equilibrium, the condition is a representation of the state of affairs in the primary and secondary circuits, just before a spark takes place. When the first pendulum is released it swings and communicates some of its

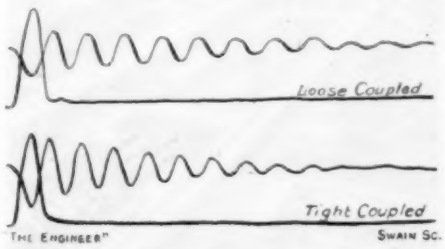


FIG. 55—UNTUNED PENDULUM CURVES

energy to the second pendulum. After one swing it may be stopped, and if necessary the cords attached to the second pendulum released, when this second pendulum swings in accordance with its natural period, until the oscillation dies down, or the first pendulum may be allowed to give two or more swings, as the oscillating current in the primary circuit of a quenched spark transmitter does before it is stopped. In this case, the increased vibration of the second pendulum which is obtained when more than one swing of the primary becomes effective, if the two pendulums are tuned, is clearly shown in Fig. 53. The tighter the coupling—*i.e.*, the tighter the rubber cord connecting the pendulums—the greater the oscillation obtained in the second pendulum will be, as shown in Fig. 54.

Experiments have also been made with the two pendulums untuned. When the coupling is tight and only one swing of the pendulum is allowed, the difference in amplitude of the resultant oscillation of the secondary pendulum when tuned and untuned is considerable, as shown in Fig. 55, the difference in natural period being as great as 20 per cent. If a loose coupling be employed and three swings of the primary pendulum are allowed—see Fig. 56—then the resultant vibration of the second pendulum is very much reduced, when the pendulums are untuned, as seen in Fig. 56B, which demonstrates that if the spark is not completely quenched and a loose coupling be employed, the circuits must be tuned in order to obtain the best results, just as in the case with persistent sparks.

In all the quenched spark experiments of which

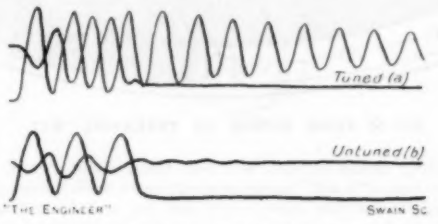


FIG. 56—CURVES SHOWING THE EFFECT OF A LOOSE COUPLING

records are given, the weight of the primary pendulum was much greater than that of the secondary pendulum. By varying the weights of the pendulums the effect of variation in the capacity of the two circuits on the resultant oscillations may be studied, and some interesting results obtained. The model exhibits one peculiarity which is not obvious at first sight, namely, that tightening the rubber cords does not increase the tightness of the coupling, this being due to the fact that the amplitude of swing of the first pendulum is limited by the mechanical construction of the model, and this first swing corresponds with a smaller percentage of elongation of the rubber cord than it does when the cord is shorter, so that although the forces acting on the pendulum are greater, the difference in tension of the cords on each side of the pendulum is less for a given magnitude of oscillation when the cords are tightly stretched. In using the model it is best to have the cords fairly loose, so as to reduce the friction at the pulleys.

London Electric Railways: Extensions.

No. IV.*

THE MORDEN EXTENSION OF THE CITY AND SOUTH LONDON RAILWAY (*concluded*).

THE length of the Morden extension is 5 miles 15 chains, and the various stations are at the following distances from Clapham Common Station:—Clapham South, 4134ft.; Balham, 7920ft.; Trinity-road, 11,166ft.; Tooting Broadway, 14,866ft.; Colliers Wood, 18,881ft.; South Wimbledon, 22,600ft.; Morden, south end, 27,676ft. The combined length of

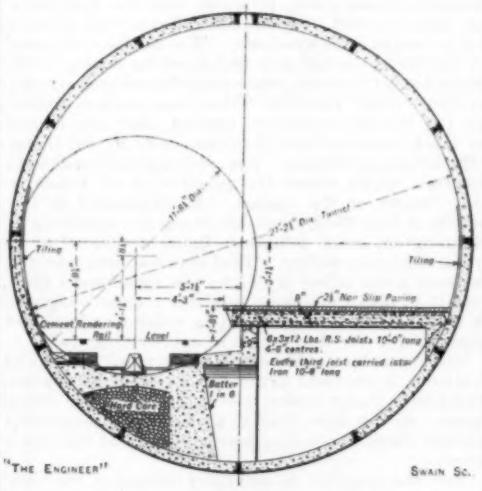


FIG. 32—CROSS SECTION AT STATION

the northbound and southbound tunnels up to the end of the iron tunnels at Dorset-road, is 47,920ft., of which 4219ft. are in station tunnels.

The usual accelerating gradient of 1 in 30 falling is provided on leaving each station, and the decelerating gradient of 1 in 60 rising in the approaches. The only other gradients of note are:—1 in 78 rising in the northbound tunnel, and falling in the southbound between Trinity-road and Tooting Broadway; 1 in 60 rising in the southbound and 1 in 60 falling in the northbound between South Wimbledon and a point 243ft. south of Dorset-road. Thence for a distance of 880ft. both lines rise towards the south at an inclination of 1 in 331, and the remaining 340ft. to the entrance to Morden Station are 1 in 50. Except for a short length near Clapham South Station no curve is of a sharper radius than 20 chains. The exception has a radius of 15 chains, and at that point 120 rings of tunnel were enlarged to 12ft. internal diameter by the insertion of 2½in. packings at the joints.

Between Clapham Common and Dorset-road, exclusive of the escalator tunnels, approximately 55,200 tons of cast iron segments have been placed, including 76 rings of 25ft. internal diameter, 2696 of 21ft. 2½in., 32 of 18ft., 159 of 15ft., 56 of 13ft. 1⅞in., 181 of 12ft. 6in., and 26,230 of 11ft. 8¼in. The total amount of excavation between the same points, exclusive of the escalator tunnels, was 278,653 cubic yards.

The maximum rates of progress obtained in the construction of the running and station tunnels under the different methods of operation and with a working week of 136 hours in compressed air and with one of 114 hours in free air, were as follows:—

	Working hours.	Rings.	Feet.
Rotary excavator in free air	114	106	179
Greathead shield in free air	114	53	89
Greathead shield in compressed air	136	51	86
Greathead shield in compressed air	114	43	72
Rotary excavator in compressed air	136	79	134
Hand tunnelling in free air	114	25	42
Hand tunnelling in compressed air	136	23	39
Station tunnels in free air	114	30	45
Station tunnels in compressed air	136	18	27

Except at Morden each station platform is in its own station tunnel, and the platforms are 350ft. long. Communicating passages, 11ft. 8¼in. wide, are

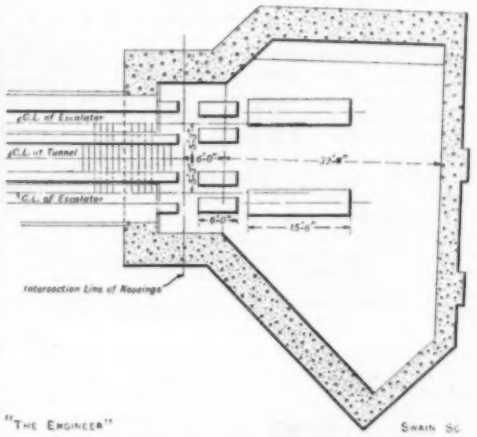


FIG. 33—MACHINE CHAMBER

provided between the northbound and southbound platforms at stations, and from each platform there is an opening to the escalators. At intervals between the stations there are connecting passages, 7ft. 6in. high and 3ft. 4in. wide, to allow for the permanent way and signal gangs to pass from one adjoining tunnel to the other.

TRACK, SIGNALLING AND STATIONS.

Having now completed our description of the construction of the tunnels, we would say that the permanent way, which has been laid by the railway company's own staff, is to the cross-section shown in Fig. 34. British standard bull-headed rails, 42ft. long, and weighing 95 lb. per yard, are employed. The rail is carried in 50 lb. chairs laid on 5in. by 12in. jarrah sleepers, 6ft. 6in. long, with a ¼in. cork-lino pad between the chair and the sleeper. The fastenings are three 1in. diameter screw spikes and an oak key. The sleepers carrying insulators for the conductor rails are 7ft. long. There are fourteen sleepers per rail length, laid at 3ft. 4in. centres except at the joints, where they are 1ft. 10in. centres. The conductor rails weigh 85 lb. per yard.

The cross-section of a station tunnel and of a platform—given in Fig. 32—is mainly presented to show a new departure made on this extension. The ordinary cross sleepers for carrying the rail chairs are not laid through stations. Instead, longitudinal timbers are provided for the chairs, and wood blocks set in concrete to take the insulators for the negative conductor rail. In the intervening longitudinal spaces there is a concrete pit. These pits have been furnished so that any passenger who falls on to the line will have a chance of rolling into the pit and so escape being run over.

The signalling, which has also been carried out by the railway company, is automatic in its operation, and, as on most of the lines belonging to the London Electric Railways Company, is on the electro-pneumatic principle. The signals are of the two-aspect colour light type, and have electro-pneumatic train

* No. III. appeared September 10th.

stops, fitted with a proving scheme to insure that they return to the normal position after the passage of a train. The track circuits are of the condenser-fed type, which is now the standard for the Underground Railways.

There are two signal-boxes on the extension; one at Tooting Broadway and the other at Morden Station. The former, which works the siding connection at that station, and which was referred to in our article of August 13th, has an electro-pneumatic power frame of fifteen levers, four of which are spare. Only when the siding has to be used, as, for instance, when a southbound train is not proceeding further and has to reverse, is the signal-box opened. The running signals, at other times, work automatically, but, when the siding has to be used, levers controlling those signals are put from their "over" position to "back" in the locking frame, with the result that the running signals are put to, and locked at, "danger," and the siding points freed. When the shunting movement has been made, the siding points are restored and the levers controlling the running signals are again free, so that, when pulled to the "over" position, the signals are once more able to operate automatically, provided that the king lever has been reversed. Signals controlled in that manner are known as semi-automatic. The initial movement in the use of the siding is performed by a king lever, which holds the levers, controlling the running signals, in their "over" position. The points are also worked by the electro-pneumatic method, and are locked by track-circuit so that they cannot be moved if any vehicle be foul of them. The cabin has an illuminated diagram, which shows the position of all trains in the vicinity of the station. As mentioned in our article of July 23rd, when describing the signalling at Kennington, green miniature lights are switched in when sections are clear. That idea has been adopted because green is less trying to the signalman's eyes, and it is also the colour used for "clear" signals. A train describer is provided in order to advise the signalman of the destination of approaching trains.

The signal-box at Morden is at the north end of the station. It contains thirty-one levers in an electro-pneumatic power frame, eleven of the levers being spare. In the depôt yard is a mechanically-operated ground frame, containing four working and two spare levers.

For the purpose of promptly advising the sub-station to cut off current, two uninsulated phosphor-bronze wires are run throughout the tunnels. It only is necessary to rub these two wires together and make a contact to cause a hooter to blow in the sub-station, an illuminated sign, describing the road concerned, to be lit up, and a ball to drop. The ball automatically trips the traction circuit breaker in the sub-station, thus making the conductor rails in the section whence the call has come instantly dead. The motorman then joins a portable telephone head-set to the wire, and he is able to advise the sub-station what is amiss.

The station buildings have been designed by the railway company's architectural officer. Both externally and internally they are of a useful and pleasing type, and show that refined taste which now characterises our Underground stations. The entrances from the street are built of Portland stone, with blue enamel and bronze in the fascia of the canopies to give a touch of colour. The name of each station is publicly exhibited in blue letters. Steps from the street level give access to the booking halls or circulating areas which cover from 1750 to 3000 square feet. Passimeter booking offices have been provided and are fixed at the head of the esca

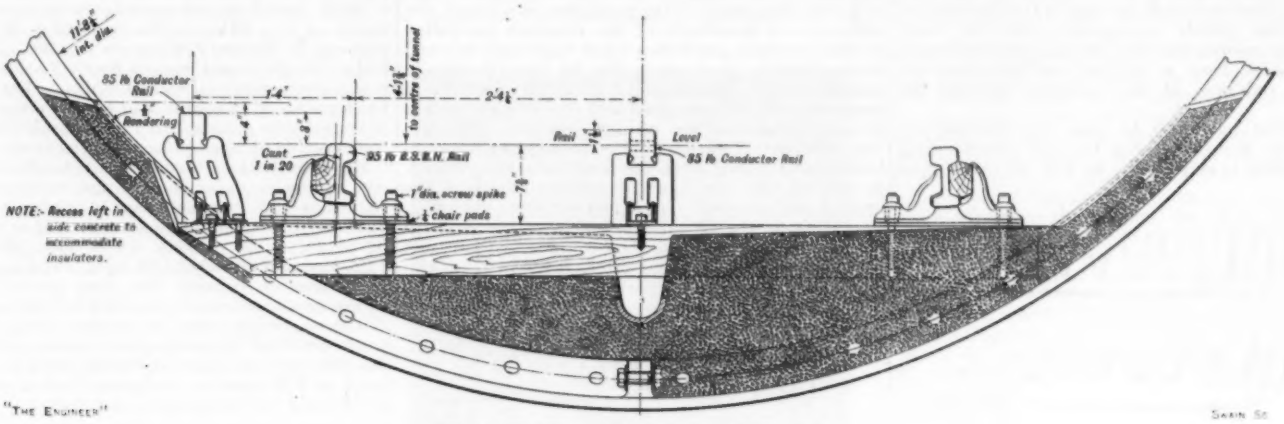


FIG. 34—CROSS SECTION OF PERMANENT WAY

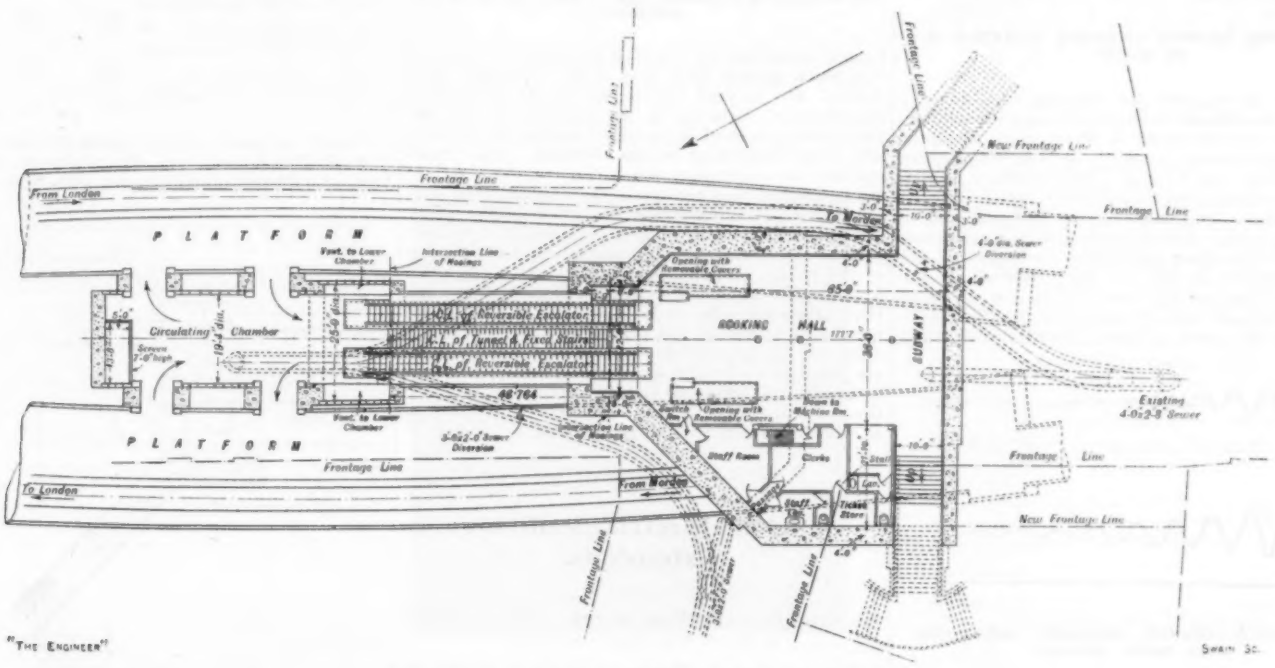


FIG. 35—PLAN OF BALHAM STATION SHOWING ESCALATORS

FIG. 36—TEMPORARY WORK

FIG. 37—TROUGHING IN POSITION

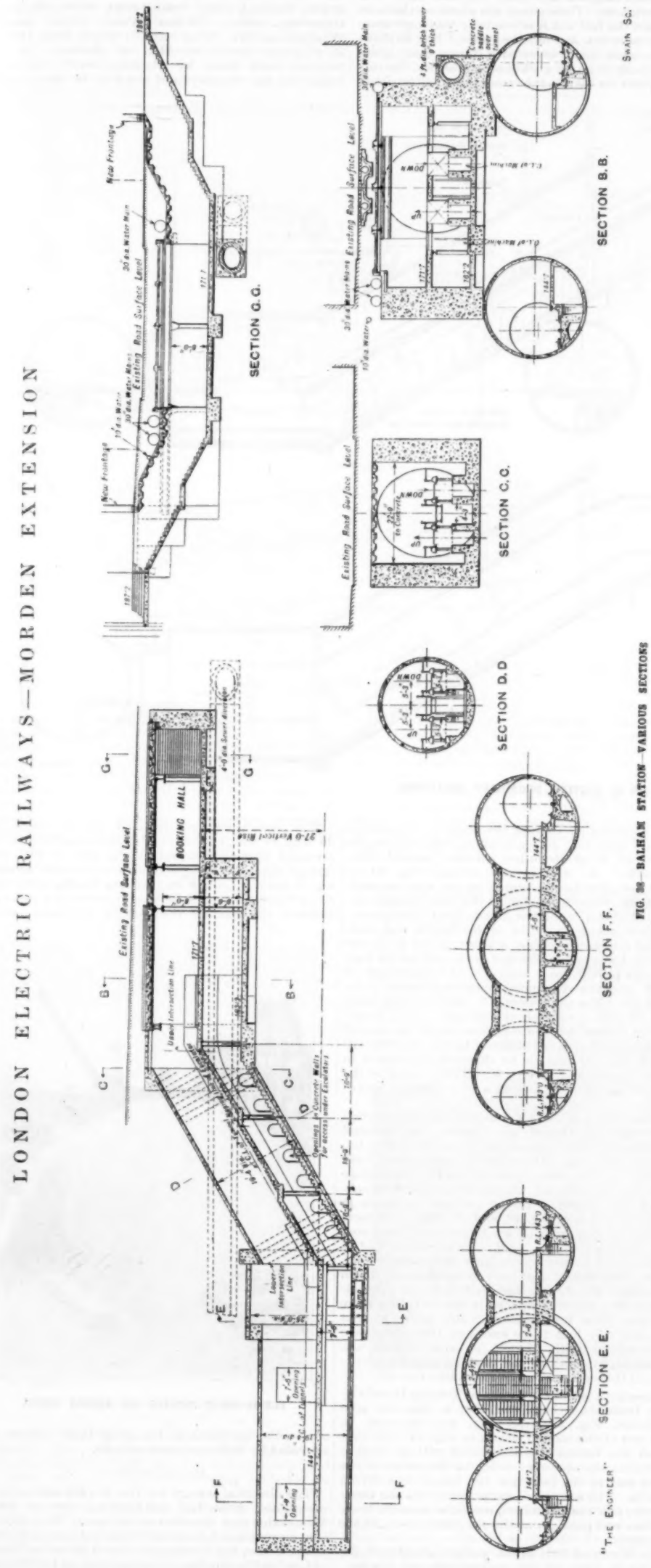


FIG. 38—BALHAM STATION—VARIOUS SECTIONS

lators. For the present and until about December the station at Balham will not be opened.

ESCALATORS.

There is a pair of escalators of the comb type at each station, and a fixed stairway between them. Normally, there is one ascending and one descending, but both can travel in the same direction. In the morning rush hours, therefore, both run in the descending direction; in the busy hours of the late afternoon and early evening both are ascending. There are, however, no escalators at Morden, as the station there is in the open and just below the level of the main road.

All the escalators, except those at Tooting Broadway Station, *i.e.*, at Clapham South, Balham, Trinity-road, Colliers Wood and South Wimbledon, are parallel with the running lines. At Tooting Broadway they are at right-angles to the lines, and approach the station from the east or southbound line side. The excavations for, and the building of, the escalator tunnels, the lower chambers for the escalator gear and the passages for passengers, the machinery chambers on the upper floor and the booking halls have been carried out by the same contractors as those who made the running and station tunnels, *i.e.*, Charles Brand and Son at Clapham South, Balham and Trinity-road, and the Foundation Company at Tooting Broadway, Colliers Wood and South Wimbledon. The work has been done to plans prepared by and under the supervision of the consulting engineers to the City and South London Railway, Messrs. Mott, Hay and Anderson. The escalators themselves and their machinery have been installed by the Waygood-Otis Company, and that particular work was superintended by the railway company's mechanical engineering department.

It will be convenient to take the escalator at Balham as a typical example, and a plan of that station is reproduced in Fig. 33. The station is under Balham High-road, and the first step was to remove the road surface and concreting on the main road, and to lay heavy timbers instead, so as to arch the width of the future headings. Shafts were sunk on each side of the road to a depth of about 9ft., and headings driven to the end of the side walls—at the top of the escalators in the plan of the booking hall—and timbered. Excavations for the walls were then made and the walls built to a suitable height. The side walls may be seen in the cross-sections B B and C C in Fig. 38. From the headings for the side walls cross headings were driven for the back wall of the machinery chamber. The machinery chamber is seen under the booking hall in the section A A, Fig. 38, and in Fig. 33, while the back wall is in the position shown in dotted lines in the plan of the booking hall, Fig. 35. Headings were also driven for the approaches to the stanchion pits and for the girders to support the steel work for carrying the road.

There is a double track of London County Council tramways, and as soon as the girders were in position, temporary steel joists and timber packing were laid thereon to support the tram lines, whilst the troughing to carry the road was slid into position. The roadway west of the city-bound tram line was dealt with first; then that tram line and afterwards the other tram line, and, finally, the roadway on the east side of the road. Sections B B and G G—Fig. 38—indicate those details. On the completion of those operations the work of excavating for the booking hall, entrances and machinery chamber was proceeded with.

Meanwhile the excavation for the circulating chamber at platform level and for the lower machinery room was effected from the running tunnels, and the spoil removed through those tunnels. Access was thereby obtained to the foot of the escalator tunnel. In the building of the latter a pilot tunnel was driven upwards; as will be explained directly, the pilot tunnel at Tooting Broadway was driven in the opposite direction. At Balham and the other stations, except Tooting Broadway, the pilot tunnel was driven by hand, in free air, and was of 10ft. 6in. internal diameter. The rings used were those recovered from the City and South London running tunnels, when they were enlarged, in 1922–24, to the standard dimensions. During that operation the circulating chamber at platform level and the lower machinery chamber were being completed. They are shown in plan in Fig. 35, and in side and end elevation in sections A A, E E, and F F in Fig. 38. The work in the booking hall and on the escalator tunnels were kept separate, and were not opened out until the roof over the booking hall was completed.

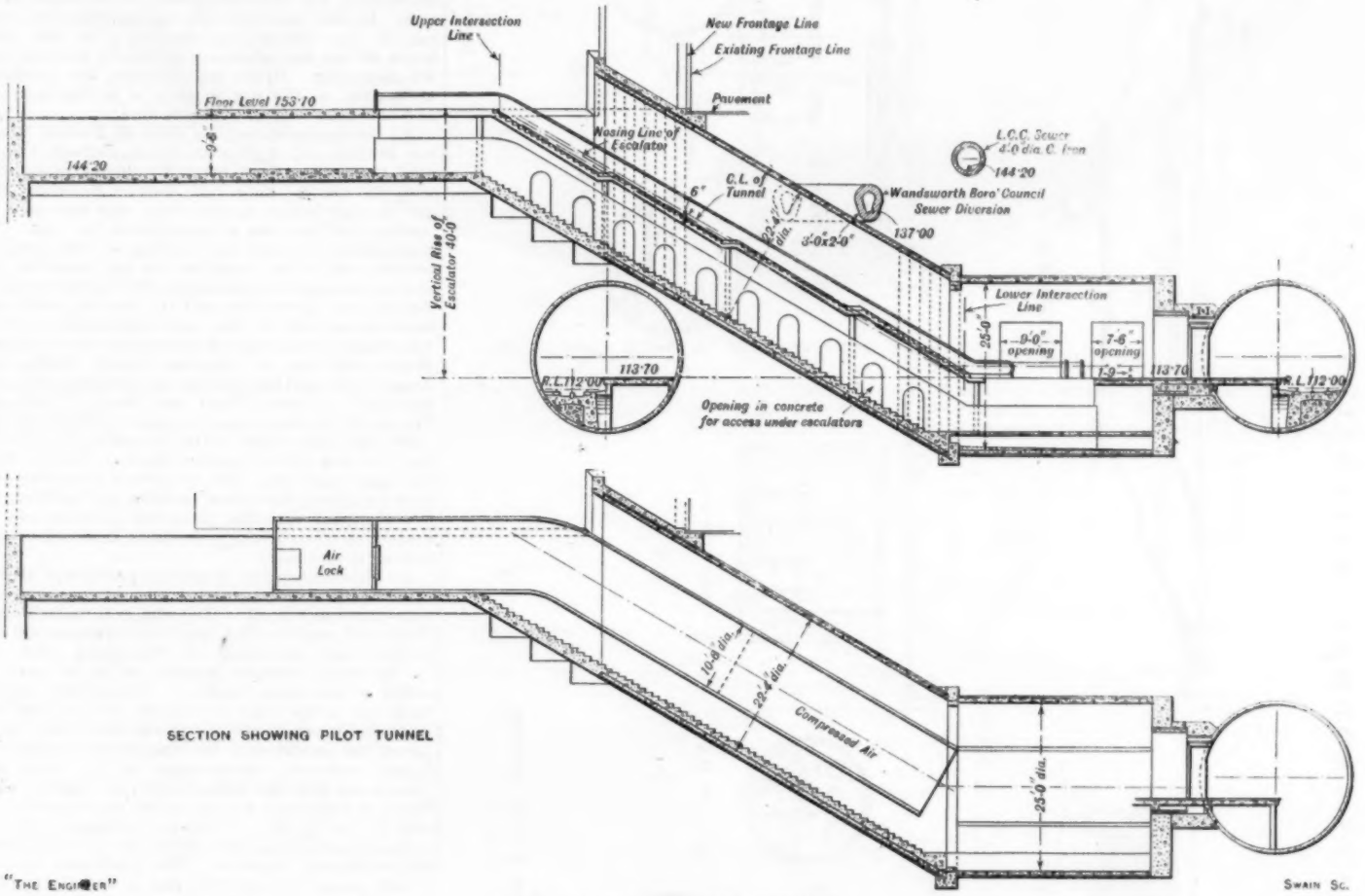
On the completion of the pilot tunnel the escalator tunnel proper, 19ft. 4in. in internal diameter, was broken out by hand and in free air, except, again, at Tooting Broadway. It is shown in side elevation in section A A, Fig. 38. The top of the escalators, with the fixed stairway between, is seen in end elevation in section C C; a cross-section of the escalator tunnel complete is given in section D D, and the foot of the escalators, the two passage ways and the two platforms in E E.

The rings at the top and bottom of the escalator tunnel were not wholly completed in a circle, otherwise there would have been a lower projection at the top and an upper projection at the bottom of the tunnel.

That is made clear by the dotted lines in the elevation —Fig. 36. The projecting portions in each case were not provided, and the junction between the sloping tunnel and the horizontal chamber at the top—marked "upper intersection line"—and between the horizontal chamber at the bottom—marked "lower intersection line"—were formed by a concrete eye.

of the tram, omnibus and other vehicular traffic that was experienced Throughout the whole of the work at Balham the full width of roadway was kept open, and at no time was any barricaded off. Fig. 40 shows two 30in. water mains diverted at Trinity-road, and is characteristic of similar work at other stations. The timber supports for carrying the tram track will be noted.

the vertical rises being as follows:—Clapham South, 59½ft.; Balham, 27ft.; Trinity-road, 36½ft.; Tooting Broadway, 40ft.; Colliers Wood, 42ft.; South Wimbledon, 43ft. They vary in length from 119ft. at Clapham South to 54ft. at Balham. It is believed that those at Clapham South are the longest in this country and possibly in the world.



SECTION SHOWING PILOT TUNNEL

FIG. 39—TOOTING BROADWAY ESCALATOR

It should be noted that at Balham there had to be the diversion of three 30in. water mains, a London County Council 4ft. by 2ft. 8in. sewer, a local 3ft. by 2ft. sewer, a 15in. gas main, a 10in. water main, London County Council electric tram cables, Post Office cables and sundry gas and water mains. The concrete saddle over the southbound running tunnel

FIG. 40—WATER MAINS

necessitated by the 4ft. sewer is seen in the section B B, Fig. 38.

Fig. 36 gives an idea of the temporary supports of the west tramway track at Balham. The temporary joists are seen resting on the main girders in order to give space for the erection of the steel troughing that rests on the main girders; whilst Fig. 37 shows the troughing in position under the temporary supports for the track. The views give an idea also of the length of track that had to be dealt with and

The escalator at Tooting Broadway is exceptional in several respects. It, for instance, is at right angles to, and not, as at the other stations, parallel with, the tracks. As seen in the section—Fig. 39—it crosses the southbound tunnel on its way to reach the station platforms. Again, the pilot tunnel was driven by hand from the street level downwards, and when about one-third of its length had been executed the water-bearing strata referred to in our article of August 13th was met with, and an air lock had to be provided—as shown in the lower part of Fig. 39—and the remainder completed under compressed air. The pilot tunnel is seen at street level in Fig. 41, just as it enters the ground. Then, before the main tunnel for the escalator could be opened out a 3ft. by 2ft. sewer belonging to the Wandsworth Borough Council had to be diverted, as shown in the plan reproduced in Fig. 42. That, owing to the nature of the ground, proved a very difficult undertaking.

On completion of the pilot tunnel, the construction of the full size tunnel was begun. Its internal diameter, again, differs from the others, as it is 22ft. 4in. instead of 19ft. 4in. The work was commenced from the bottom under compressed air, and as the surface was being approached it was found necessary to consolidate the ground. The strata was as shown in the elevation A A in Fig. 42, and the difficulties were overcome by constructing what amounted to a concrete cofferdam in the sand strata, which had a pressure of 15 lb. per square inch under about 11ft. of clay. The ballast near the top for the area shown in the plan in Fig. 42 was then grouted by the François cementation process. As seen in the elevation there were three 30in. high-pressure water mains at that point, and care had to be exercised that they were not interfered with. Later, as the surface was approached, compressed air working was impracticable, and the work was completed under free air.

In one last respect the tunnel at Tooting Broadway differs from the others, and that is that—as seen in section, Fig. 39—the rings are elliptical in shape and of the section shown in Fig. 43. By that method the tunnel was excavated with a vertical face, which was necessary owing to the nature of the ground and to the fact that the tunnel was driven upwards. The amount of excavation from the booking halls, machine chambers, escalator tunnels, lower chambers and passages at the six stations was 25,500 cubic yards.

Two Waygood-Otis latest pattern escalators are installed at each of the undermentioned stations,

The escalators are inclined at an angle of 30 deg. to the horizontal, and the machinery is so arranged that they travel at the rate of 90ft. per minute linear speed. The motors vary in size according to the rise; those at Clapham South, where the rise is highest, being of 50 horse-power each; those at Balham, the shortest rise, are of 30 horse-power,

FIG. 41—PILOT TUNNEL AT STREET LEVEL

whilst the machines at the other four stations are operated by 40 horse-power motors.

POWER SUPPLY.

The electrical energy for the Morden extension is distributed from two sub-stations, one at South Wimbledon and the other at Balham. The high-tension current is not, however, furnished from Lots-road power-house, but is being purchased from the County of London Electric Supply Corporation, at 11,000 volts,

three-phase, 50 cycles. Power is generated at its Barking power station and supplied from Gorringe Park sub-station to Colliers Wood, where there is a switch and meter room—Fig. 44. The switchgear is of the ironclad type. Thence two cables run through the tube—one in each tunnel—to South Wimbledon sub-station and from that point two smaller cables go to Balham sub-station.

South Wimbledon is manually operated and Balham is remote controlled therefrom. The former is equipped with three 50-cycle, 1200-kilowatt rotaries 500 revolutions per minute, with space for a fourth machine if it should be required. The high-tension current is stepped down in air blast transformers to 380 volts for the rotaries. The banks consist of three single-phase transformers, each wound with two secondaries. The transformers are connected delta primary and double delta secondaries to produce six-phase. The high-tension oil switches are of the ironclad type, hand operated. The high-tension bus-bars, isolating links, &c., are, however, enclosed in brick cubicles, that method being preferred to ironclad bus-bars.

The low-tension switchboard is fitted for the control of 600 volts direct-current supply to contact rails and escalator feeders. The circuit breakers on the board are of the hand-operated high-speed type, the track breakers being of 3000 ampères normal rating. These breakers are remarkably effective; they have, on test at the maker's works, broken short-circuit currents, which have risen to 12,000 ampères in ·0081 seconds, without the rotary converters flashing over. That was on a short circuit of which, if it had not been broken by a high-speed breaker, the maximum value of the current would probably have amounted to 25,000 ampères or more.

South Wimbledon sub-station is also equipped with a 450-kilowatt bank of transformers of the air blast type for supplying 440 volts, three-phase, to the lighting feeders on the railway. At each station the 440 volts pressure is stepped down to 220 volts for local lighting.

The electrical supply for the signalling is provided for by a single-phase transformer, 11,000 volts to 650 volts, the 650 volts being cut down to suitable low voltages at various signal distributing centres.

At the end of the low-tension switchboard at South Wimbledon there is a panel on which is fitted apparatus for the remote control of Balham sub-station. From there all the plant at Balham may be put in or taken out of service and indications are given on the panel as to the position of the plant. Ammeters also are provided which indicate the current output from that sub-station. The panel at South Wimbledon is connected to Balham by two ten-core pilot cables, through which the controls are operated. Balham sub-station is equipped with three 1500-kilowatt, 50-cycle, six-phase rotaries, with space for a fourth rotary if it should be required in the future. It is fully provided with remote control automatic apparatus so as normally to be an unattended station. The machines and equipment were manufactured and installed by the Metropolitan-Vickers Electrical Co.

The high-tension switches are motor operated and are closed and opened from the control panel at South Wimbledon, as already noted. To put a rotary into service the appropriate push button is pressed at South Wimbledon, thus causing the rotary oil switch to close at Balham. On closing the switch the rotary transformers are livened, the transformer cooling air fan runs up and the exciter, being attached to the fan motor, does so at the same time. The starting motor then starts the rotary, at first separately excited. As the rotary pressure builds up to about 200 volts the machine becomes self-excited, and automatically the exciter is switched off. The rotary runs up to synchronism and, after polarity has been checked by a polarised motor relay, the rotary synchronises, the main alternating-current contactors close and the starting motor switches off. Circuit breakers then close on the direct-current side, putting the machine on to the bus-bars. A special relay and resistance has been fixed so as to provide for a cold machine paralleling a hot one already on load.

Each rotary unit is fully equipped with protective devices to guard against almost all known causes of trouble. Thermostats are fitted to bearings and windings, and any excessive overheating causes the machine to shut down. When that happens indication is given to South Wimbledon that, for some reason, the machine is shut down.

The track feeders from Balham switchboard to the contact rails are protected by solenoid-operated high-speed breakers which are controlled from South Wimbledon. Each of the breaker panels is equipped with a periodic re-closing relay. The function of that relay is to cause automatic re-closing of the circuit breaker, after an interval of thirty seconds, in the event of the circuit breaker being tripped owing to a fault on the track. The relay may be set to re-close the circuit breaker one, two, three, or four times, after which setting the breaker is locked out and indication is given to South Wimbledon that it has locked out. When the fault on the track has been cleared the attendant at South Wimbledon may re-close the breaker. The object of re-closing several times is because it is found in traction experience that quite a number of momentary "shorts," such as those produced by low shoes, clear themselves without the necessity of keeping the track dead any length of time.

Balham sub-station is ventilated similarly to that at South Wimbledon, viz., by a fan drawing air through a washer. Air compressors and lighting transformers of like make and capacity to those at South Wimbledon have also been installed.

ROLLING STOCK.

The new rolling stock for use on the Morden extension and for the new connection between Charing Cross and Kennington comprises a hundred motor cars and ninety-two control trailer cars, built by Cammell Laird and Co. and by the Metropolitan Carriage, Wagon and Finance Company, and fifty-five trailer cars, built by the Birmingham Railway Carriage and Wagon Company and the Metropolitan Carriage, Wagon and Finance Company. All the cars are of steel construction, the principal dimensions being:—Overall length, 49ft. 9¼in.; width, 8ft. 6¾in.;

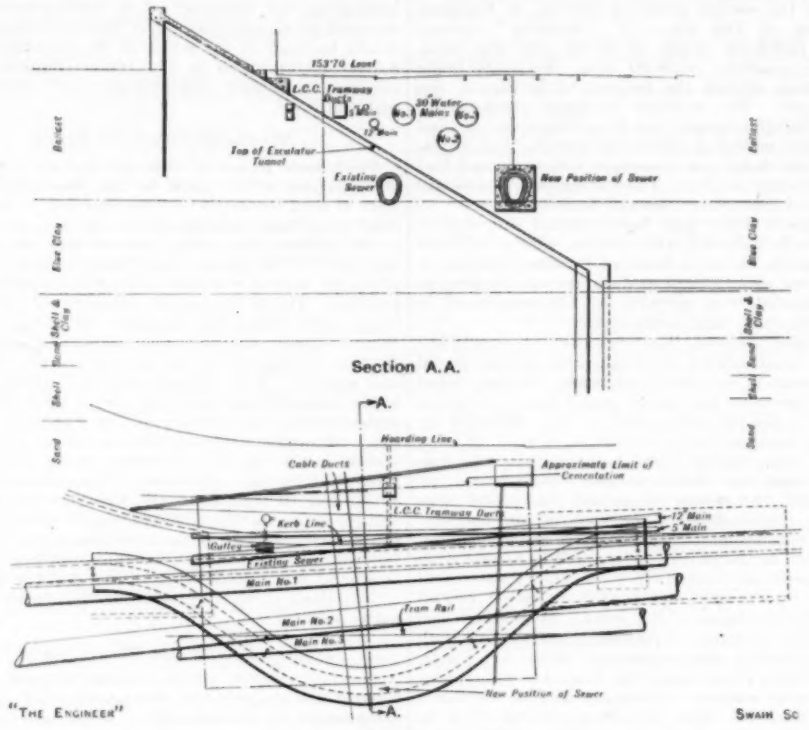


FIG. 42—DIVERSION OF SEWER

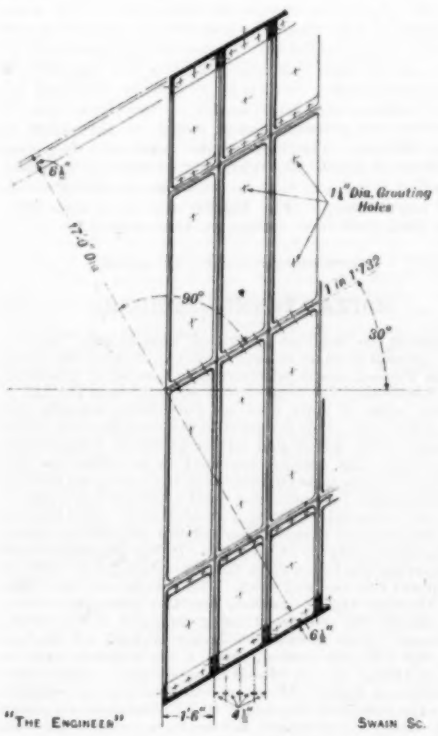


FIG. 43—ESCALATOR TUNNEL SECTION

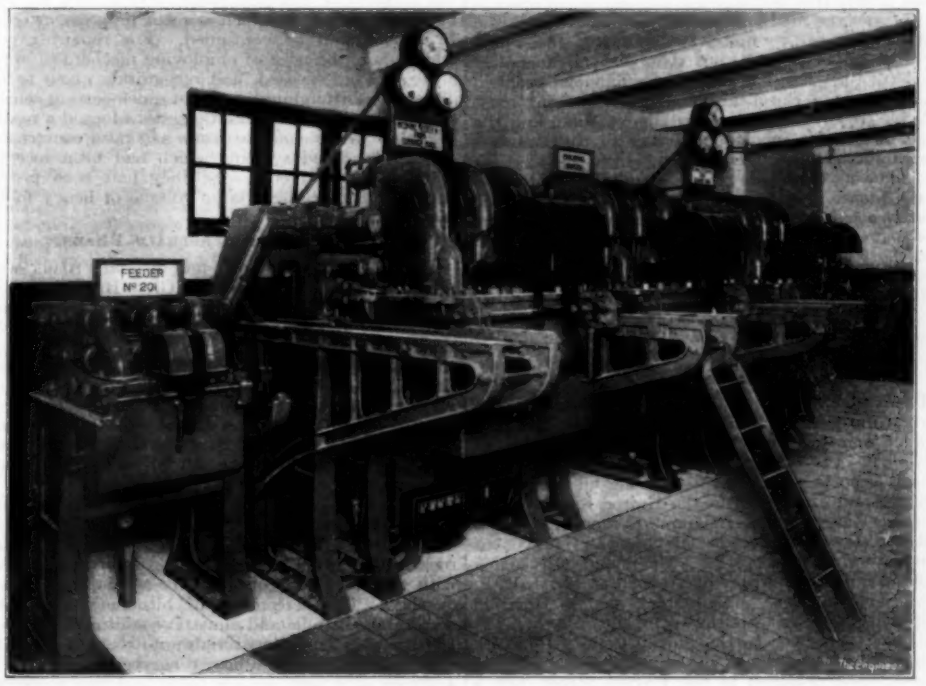


FIG. 44—SWITCH ROOM, COLLIERS WOOD

overall height from running rail, 9ft. 6in. The approximate weights are:—Motor cars, 32 tons; control trailer cars, 19¾ tons; trailer cars, 18¼ tons.

The cars are of a clean flush finish, except in the waist panels, where shallow snap rivets are introduced. The roof is partly of the elliptic type and partly of the clerestory type, in order to provide doorway head room and ventilation respectively. The ventilation is principally effected by air scoops fitted into the clerestory and ornamental grills fitted on the inside of the car. In order to reduce the amount of tunnel noises the interior grills are not directly opposite the air scoops. Further ventilation is provided by certain of the side windows, which are arranged to open 3in. The reduction of noise has been provided for by a lining of asbestos between the outer and inner sheetings.

The cars are close coupled and a spring fender is provided at each end. They are carried on centre bearings of the ball-bearing type, whilst the side bearings are of the hard steel roller type which bear on a hard steel wearing plate.

The brake system is of the air brake type, and an electrical device is fitted and so arranged that a light burns over the motorman's head so long as the brakes are applied on any car on a train. A control governor on each motor car prevents the motorman starting a train until there is enough air in the air brake system to apply the brakes satisfactorily.

The side doors are double sliding doors, which work on roller bearings. Each door is worked by an electrically controlled air engine. The seating capacities are:—Motor cars, thirty passengers; control trailers, forty-four passengers; trailer cars, forty-eight passengers.

The electrical traction equipment is of the "all-electric" type with automatic acceleration, manufactured by the General Electric Company, Ltd. The motors used have an output of 230 brake horsepower on a one-hour rating. They are of the self-ventilated type and special attention has been given to insulation in view of the severity of the service to which they are subjected.

International Roads Congress.

ALTHOUGH it is only three years since the last meeting organised by the Permanent International Association of Road Congresses was held at Seville, the phase into which the road problem has now entered gives ample justification for the holding of the Italian Congress, the main work of which was done in Milan last week, but which held the final meeting in Rome on Monday last, September 13th.

In all countries the growth of motor traffic is creating an insistent demand for more and better roads, and it is probable that never in the history of the world has the mileage and character of existing highways fallen so far in arrear of actual needs. It is not merely that the engineer is being called upon to reconstruct the road systems of the world to meet the demands imposed by motor traffic, a task with which he is well able to cope, but that with the technical aspect of the subject is bound up a financial problem which in many European countries is proving most difficult to solve. The proceedings at Milan and the large number of reports presented to the Congress have indicated the energy with which the work of consolidating the roads position against the invasion of the motor vehicle is being conducted. The wide interest aroused by the Congress was revealed by the fact that over fifty official delegations were appointed, and that considerably over 1000 members attended. Government Departments, the engineering profession, provincial, county and municipal authorities and users of the roads were represented, and a good deal of useful work was accomplished.

CONCRETE ROADS.

The engineering aspects of the Congress covered a fairly wide field, including concrete roads, bitumen, asphalt and tar surfacings, and standardisation of materials. On the subject of concrete roads, over twenty reports were presented giving an account of practice and experience in the United States, Great Britain, Italy, France, Belgium, Denmark, Sweden, and the Low Countries. The reporters for Great Britain were Mr. C. M. G. Richmond (Divisional Roads Engineer, Ministry of Transport), Mr. J. B. L. Meek (city engineer, Manchester), Mr. A. Harrison (borough engineer, Southwark), and Mr. W. P. Robinson (surveyor to the Surrey County Council). The greatest experience of concrete roads has, of course, been obtained in the United States, but a considerable experience has also been obtained with highways of this type in Great Britain and other parts of Europe, a notable example which delegates had an opportunity of inspecting being the Milan–Larghi motor road, 85 kiloms. in length. At the Seville Congress the composition by volume of concrete was fixed at 1–2–3·5. In the construction of the Milan–Larghi road, a 1–2–3 proportion has been adopted with excellent results. The American specification fixes the proportions at 1 part cement, 2 of fine aggregate and 4 of coarse aggregate.

The British report dealt with several types of concrete construction, including six experimental sections of concrete roads in Manchester and new roads in country areas in Surrey. The Belgian and Italian reports referred to several instances of concrete roads made on patented systems. In Belgium such roads had, it was stated, been built by the Rhoubenite and "Soliditit Belga" processes, and in Italy by the Soliditit Patent process. In the latest applications of the first process a mixture of 5 cubic metres of rubble, 5 cubic metres of flat porphyry stone, 3 cubic metres of Rhine sand, Portland cement (350 kilos.), and Houben powder (16·8 kilos.) was used. In the second patented process, in Belgium, a mixture of 700 kilos. of "Soliditit" cement and flat porphyry stones of 10–50 mm. was used, a certain quantity of 9–20 mm. chippings being incorporated, during the process of laying, in the upper layer. The mixture in Italy consisted of 50 kilos. Soliditit cement per 45 cubic metres of sand and 75 cubic metres of rubble and gravel. The results obtained by these processes were different, and had been differently judged. The testing period was still too short to draw conclusions of decisive value.

In Belgium there had been carried out experiments also in surfacing with Gunite, with or without reinforcement, having a basis of Portland cement or iron slag cement. Practical data are still lacking as to the expediency of carrying out surfacing work in ordinary concrete with furnace slag.

The report showed that considerable experience had now accumulated of single and double metal reinforcement in concrete road work. It was stated that reinforcement had not in many cases prevented cracking of the concrete, while it was attended by additional expense and rendered the work of construction and repair more complicated. It was suggested that the whole question should be further investigated, but it was recognised that metal reinforcement represented, in the case of non-homogeneous or weak foundations, a valuable aid in ensuring the stability of the pavement, subject to ascertaining in each particular case whether the same result could not be more cheaply and readily obtained by increasing the thickness of the layer. An account was given of the numerous experiments carried out with both longitudinal and transverse expansion joints, but no definite decision on the subject could, it was stated, yet be reached. In American practice joints of this character were rarely employed, and in countries where they had been used a great variation of opinion was disclosed as to the most suitable distances for the cross joint. The conclusion reached was that the experimental tests undertaken with a view to deciding the best type of reinforcement for expansion joints must be continued. It was also decided that the practice of constructing roads with alternating slabs for the purpose of reducing the dimensions of expansion joints and of diminishing cracks was worthy of further investigation. Coating concrete roads with mineral oils or bituminous mixtures might in many cases, it was thought, give good results, and the Congress recommended that the experiments in connection with the silicatisation of the surfaces of concrete roads, with a view to their better preservation, which were in progress in Great Britain, should be continued. For repairing concrete roads, the need of employing mechanical appliances was emphasised, and recognition given to the advantages attending the use of quick-setting cement or asphalt concretes. The Congress adopted a resolution that where concrete roads had been constructed on the improved systems which had been recently adopted by road engineers, they had been proved suitable for carrying a large volume of heavy motor traffic.

BITUMINOUS AND ASPHALT ROADS.

Reports on bituminous and asphalt roads were presented by the United States, Great Britain, France, Belgium, Italy, Sweden, Switzerland, and Holland. The British reporter was Mr. W. J. Hadfield, the city surveyor of Sheffield. It was felt in some quarters that the reports on this subject failed to do complete justice to the British tar industry, which now finds its chief outlet in the use made of the material in road engineering, but this misconception was cleared up as it was recognised that the use of tar in road work would probably be on an increasing scale. The materials used in bituminous roads dealt with in the reports were natural asphalt rock, non-asphaltic mineral materials, and bituminous materials of every description. It was laid down that the asphaltic rock must be homogeneous, entirely impregnated with bitumen, and contain only a small percentage of clay. The percentage of bitumen might vary according to traffic and climatic conditions from 6 to 13 per cent. Mineral materials not naturally asphaltic were stated to include coarse aggregate retained by a screen of 6 mm. square mesh and fine aggregate retained by a screen of 6·200 meshes per square centimetre. For filler the use of ordinary Portland cement or finely powdered hydraulic lime was recommended. With regard to binding material, the qualities on which stress was laid in the reports were adhesion, cohesion, ductility and stability. Various methods had been proposed, it was stated, for measuring adhesion, but none had been adopted in practice. Cohesion was usually measured by means of a penetrometer, and ductility by tensile stress measured on a small test piece of the material, but the English report proposed to replace this test by a melting test. Stability was ascertained by various physical and chemical tests. Stress was laid on the need of specifying tests on bitumen which might be readily carried out by the engineer in charge of the work, leaving the more complex and complete tests to be carried out in scientific laboratories.

The general conclusions on bituminous and asphaltic roads adopted by the Congress stated that the tests at present in use were sufficient on the whole to determine whether a certain bitumen was suitable for use in given conditions, but the hope was expressed that a practical method might be found of measuring the adhesion of a bituminous binding material to an aggregate, and that a complete study would be made of the action of the very fine mineral matter incorporated in bituminous binders on the so-called asphaltic characteristics of the binding material itself.

STANDARDISATION OF TESTS.

From some points of view the decision reached by the Congress with regard to the standardisation of tests of road materials may be regarded as one of the most important achievements. It was shown that at the present time, where test methods are adopted they are for the greater part those used in America, although some are derived from French and German practice. The British report enumerated the requirements with which tar intended for street purposes should comply, and expressed regret at the confusion existing in England in the nomenclature of bitumens and asphalt. The Congress decided, having regard to the extensive use which was being made of coating materials and the necessity of determining accurately their suitability for the purpose, to set up a committee consisting of a member from each nation interested in the question. This committee was authorised to submit to the Congress an exclusive nomenclature for the main products, included under the several varieties of tars, bitumens, and asphalts, the rules to be followed in the sampling of these products, and standardised forms for the principal test methods to be adopted before the materials were taken over for use.

SPECIAL ROADS FOR MOTOR TRAFFIC.

Another subject which created a good deal of interest was the proposal that special roads should be constructed for motor traffic. What has been done in Italy in this connection and the new routes proposed to link Rome with Naples, Milan with Turin and Genoa indicate that highways of this character may find favour in many countries. It was claimed for the motor road that it offered equally with the railways guarantees for order and discipline, such as could not be obtained on highways freely traversed by all classes of traffic. Opinions on the subject were shown to vary at the Congress. It was pointed out by Mr. W. Rees Jefferies on the part of the British delegation that although private motor toll roads had been proposed for Great Britain, no such schemes had received Government sanction, and there was a natural opposition from local authorities to the construction of toll roads, the ownership of which would remain in private hands. It was also pointed out by Mr. E. S. Shrapnell-Smith that the development of commercial motor transport might be retarded by such schemes, and that in any event there was no need for the construction of roads of this type in Great Britain. The view of the American delgation was that all traffic was becoming of the mechanically propelled type, and that for this reason special roads were unnecessary. The British and American delegates abstained from voting on this subject.

MOFFAT TUNNEL ACCIDENT.

DESPITE the fact that water, soft ground and "squeezing" ground have all caused trouble in driving the 5-mile Moffat Tunnel, described recently in a series of articles in THE ENGINEER, the first serious accident was the fall of a great mass of solid rock on July 30th, burying and killing six men. This occurred in the west heading of the railway tunnel, which had advanced about 2 miles from the portal. The granite appeared to be solid, but was broken by seams in both directions, so that as the heading penetrated this formation it caused a slide or fall from the roof and north side, leaving a great cavern. The heading was only a short distance beyond the permanent timber lining, which latter held its place. In the dangerous work of removing the fallen rock, timber cribbing was built up to support the roof and sides. The cavern was then filled with timbers, tightly packed, and the permanent lining was placed, the crib work being removed as this lining advanced. This permanent lining is built of timbers 12in. by 18in. in section, with a five-segment arch or roof, and these sets are placed close together, so as to form a continuous lining. Work on the heading was renewed about the middle of August, at which time there remained about 4300ft. to be driven before the meeting of the east and west headings.

OWING to the continuance of the coal stoppage, says the National Federation of Iron and Steel Manufacturers, furnaces in blast again declined, and at the end of August only six remained in operation, compared with 147 on the eve of the coal stoppage. Production of pig iron, therefore, only amounted to 13,600 tons, compared with 17,900 tons in July, and 539,100 tons in April. Production of steel ingots and castings in August amounted to 52,100 tons, compared with 32,100 tons in July and 661,000 tons in April.

Railway Matters.

As St. Enoch's Station, Glasgow, had, on Sundays, only to deal with one morning train from, and one evening train to, England, their transfer to the Central Station has allowed St. Enoch's to be wholly closed on Sundays.

The 11.50 a.m. London and North-Eastern express from King's Cross to Scarborough, which makes a non-stop run to York, covered the 188 miles to the latter city on Tuesday, the 7th inst., in 208 minutes. It lost two minutes by signals approaching Hatfield, but arrived two minutes before time. The engine was No. 2555, Centenary, and the load 333½ tons.

The Town Council of Oswestry recently had under consideration a letter from the Great Western Railway Company urging the Corporation to close two streets which would allow for the ready enlargement of the railway works there. The latter used to be the shops of the Cambrian Railway Company, and it is easy to imagine their becoming a big repairing centre for the northern section of the Great Western Company.

In connection with the extension to Morden, opened on Monday last, the London General Omnibus Company has made that station the terminus for its Worcester Park, Cheam and Burgh Heath services. Two new services have been brought into use, viz., to Banstead and to Wallington. The services work from the forecourt of the station, which has been designed, like those at Golders Green and Edgware, to act as an omnibus station.

As the night train from Glasgow, St. Enoch's, to St. Pancras was entering the Wellington Station, Leeds, in the early hours of Tuesday, the 7th, it failed to stop at the usual place and knocked down the buffers, destroyed a small electrical power-house behind, and crashed through the wooden passageway that leads to the New Station. There were no personal injuries. No. 1 road, on which the train was travelling, is outside the station walls and uncovered, so possibly the rails were greasy.

When the charge is made that an accident was due to malicious interference, there is always a certain amount of satisfaction when it is proved that such was the case. It is, therefore, a relief to hear that a couple of men have acknowledged that they removed the rail which led to the derailment of the Berlin–Cologne express near Hanover, mentioned in this column on the 3rd inst. The crime was committed with a view to robbery, but when the men saw the terrible result of their action they ran away.

The coroner's jury completed on Tuesday last, their inquiry into the nine deaths that arose out of the charabanc disaster at Naworth on August 30th. The evidence showed that the railway porter—who was himself killed—broke three important rules:—(1) He failed to look at the electrical indicator, which would have shown that the down express was approaching; (2) he failed to put the signals protecting the crossing to "danger"; and (3) he opened the nearer, instead of the further, gate first. The jury placed the blame for the death of the eight occupants of the charabanc on the deceased porter, and said that he was killed as a result of his own neglect.

According to the *Gazette de Prague*, rapid progress is being made with the electrification of the Czechoslovakian railways. The first part of the work consists of the electrification of the sidings, and the second that of the traffic lines. A 2200-kilowatt continuous current converter, with a power of 22,000 volts, is at present being constructed, as well as one of 1100 kilowatts. The question of supplying the necessary current has been settled, and it has been decided that until the large hydro-electric stations have been completed on the Elbe and at Stechovice, the current shall be obtained from the Ervenice station. When the construction of all the hydro-electric power stations contemplated has been carried out the electrification of the Prague suburban system of railways will be actively proceeded with.

The reports, by the assistant inspecting officers of the Ministry of Transport, on accidents to railway servants often reveal items of interest in railway operation. Thus Mr. J. L. M. Moore had to report on a shunter being scalded on his left foot at Stockport on the Cheshire Lines. The engine, which had brought in a train from Derby, had to be detached by the shunter who, as a preliminary, turned the cock of the steam-heating apparatus on the train side, but had a difficulty in moving the handle of the similar cock on the tender. On asking the fireman for a hammer, that man said that the valve on the footplate had been closed before reaching Stockport, so the shunter disconnected the pipes without turning the cock on the tender. The result was that steam and hot water escaped, and the shunter was scalded. The pertinent instructions to enginemen were that the valve should be closed a few miles before running into a station where vehicles are liable to be detached." Mr. Moore points out that such instructions are very vague, and liable to various interpretations, and suggests that the Midland section of the London, Midland and Scottish follows other companies in fixing a definite period of time instead of dealing with it on a mileage basis.

According to the Board of Trade Returns the value of the railway material exported during the first seven months of the present year was as follows, the corresponding figures for 1925 and 1924 being added in brackets:—Locomotives, £2,284,946 (£1,922,498, £1,339,245); rails, £1,208,619 (£1,172,386, £1,034,309); carriages, £1,495,181 (£889,051, £654,252); wagons, £1,988,851 (£2,025,583, £2,107,560); tires and axles, £184,685 (£254,895, £379,515); chairs and metal sleepers, £593,376 (£487,285, £842,221); miscellaneous permanent way, £712,244 (£781,382, £702,127); total permanent way, £3,158,887 (£3,139,779, £3,479,186). The weight of the rails exported was £153,124 tons (123,036 tons, 114,744 tons); and of the chairs and metal sleepers, 61,484 tons (42,603 tons, 67,251 tons). During the month of July last the total value of the locomotives shipped was £294,134, which included:—The Argentine, £170,274; other countries in South America, £36,559; India, £34,156; and Australia, £21,195. The rails sent overseas in July were of the value of £64,913, and included:—India, £15,119; South Africa, £11,495; the Argentine, £7446; Portuguese East Africa, £4462; and Australia, £3417.

Notes and Memoranda.

Output of petroleum products in Canada last year was worth £10,152,000, says the Dominion Bureau of Statistics, the highest since 1922. In 1923 it was £9,880,000, and in 1924 it was £9,256,000.

What is described as the largest fresh water cargo ship afloat was launched at Midland, Ontario, on August 11th. She is the Lemoine, 633ft. long, and is capable of carrying half a million bushels of wheat, or 15,000 tons. Her speed will be 13·2 knots.

In all, aircraft in Canada made 3171 flights in 1925, and covered a distance of 255,836 miles—a smaller number than in 1924, but a considerably larger number than in 1923. There were no accidents to aircraft involving injury or death in 1925.

Nearly half the world's supply of mica comes from India, according to the *Indian Engineer*. The mica mines in Bengal are near Koderma in the Hazaribagh forests and those of Madras in the Nellore district. There are also some deposits at Travancore, Mysore, and Ajmir. The Indian trade amounts in value to about a crore of rupees and the total quantity exported to about 5000 tons.

Among Australia's imports of materials of engineering origin 97 per cent. of the iron and steel, 55 per cent. of the iron and steel wire, 47 per cent. of general engineering, 70 per cent. of electrical, and 72 per cent. of cutlery, hardware, &c., are of British make. Australian imports from this country amounted to £63,000,000 in the last complete year for which figures are available. Australian exports to the United Kingdom were but £45,000,000.

Fears have, according to the *Industrial Australian*, been expressed from time to time as to the safety of the dam, built in 1887, to impound irrigation water in the Waranga Basin, Victoria. The engineer-in-charge, however, denies that there is any element of weakness in this great bank, which extends for a distance of more than 4 miles. The Waranga Basin serves 375,500 acres of irrigation land between the Goulburn and Loddon rivers, and is the largest project of its kind in Victoria.

It has been proposed by a Belgian engineer that seven barrages should be constructed across the river Congo to make the cataract region of the river above Matadi navigable for large ocean steamers, and at the same time to use the water power for the production of electricity on a large scale. Each barrage would take about four years to build, and obviously the scheme would be very costly. In view of the potential wealth of the colony and the probability of even a reconstructed railway once more failing, together with the difficulties of all railway construction through the Crystal Mountains, even the expenditure necessary for the realisation of such an ambitious project would probably be justified.

In the course of his comments on the failure of a boiler stop valve at a Midlands colliery, the Engineer-Surveyor-in-Chief, Board of Trade, remarks that the failure of the valve chest at the outlet branch appears to have been caused by excessive stresses due to bad alignment of the flanges. Care should be exercised in erecting steam pipe systems to insure that the flanges fit properly together so that jointing material of uniform thickness may be used without unduly stressing the pipes and fittings. Unless the parts are of very substantial proportions the jointing material should cover the whole of the face of the flange rather than the part within the bolt circle only. The practice of using jointing material of irregular thickness to compensate for want of alignment is not a good one.

The Board of Trade desires to call the attention of owners and masters of oil-carrying vessels to the necessity for seeing that the electric lighting installation is maintained throughout in a satisfactory condition. Lamps and other fittings and the wiring leading thereto should be suitably protected, and every precaution should be taken to avoid the risk of explosion which may be caused by sparks from defective fittings and connections. Where it is necessary to introduce a lamp into a compartment, cofferdam, or other enclosed space before it has been ascertained that the space is free of gas, only battery-fed hand lamps of a type approved by the Home Office for use in fiery coal mines should be used. Ordinary portable lamps, such as pocket torches and lamps attached to cables are unsuitable for use in dangerous spaces.

In the course of some remarks at the annual conference of the Municipal Tramways Association, Mr. A. Baker, general manager of the Birmingham Corporation tramways, said that undoubtedly the future development of passenger road transport lay with double-decker six-wheeled motor buses, having a carrying capacity of sixty-five to seventy passengers. There was no doubt that six-wheeled buses possessed many advantages over the four-wheeled type. He would be a bold man who would prophesy the future of road passenger transport. One could only judge by portents of the times. There was, in his opinion, no public service vehicle at the present time that could deal with the great density of traffic of large towns and cities so cheaply or expeditiously as the tramcar. At the same time it must be stated that, beyond a few extensions of existing tramways, no new tramways were likely to be constructed.

The serious decrease in the consumption of coal in Bombay is pointed out by the Indian Tariff Board in its report on the coal industry. In the four years immediately preceding the war, the supplies of coal which reached Bombay amounted to 1,200,000 tons a year. The present average consumption is only 600,000 tons. This is attributable not to any decline in industrial activity, but mainly to the displacement of coal by hydro-electricity and fuel oil. In 1913–14 there were 82 cotton mills in Bombay City and Island, all of which used coal as their sole source of power. In 1924–25, 61 mills used hydro-electricity as their main source of power, 23 used fuel oil, while the number of mills still dependent entirely on coal was 17 only. The power supplied by the Tata Hydro-electric Companies in 1924–25 was equivalent to about 400,000 tons of coal, while the imports of oil amounted to 60 million gallons, which may be taken as equivalent to 450,000 tons of coal. The completion of the new hydro-electric stations will lead to a further displacement of coal by electricity.

Miscellanea.

An electric power station is to be put up at Jalalabad, Afghanistan.

A new rod mill is being erected at the Cwrtybella Works, Newport, of the Whitehead Iron and Steel Company.

A large road construction programme, upon which 80 million dollars will be spent, is to be carried through in Cuba within the next two years.

The first of the new fleet of motor omnibuses built for the Glasgow General Omnibus and Motor Services by the A.E.C., of Walthamstow, arrived in Glasgow on the 10th inst.

The new wire and wire nail works of Karahgatch, Turkey, have, according to the *Ironmonger*, begun work. The monthly output will be about 400 tons of wire and nails—40 per cent. nails—which is about 30 per cent. of the Turkish demand.

In 1925 Canada produced 8692 oz. of platinium and 8288 oz. of palladium, rhodium, iridium, &c. Except for a short amount recovered from the placer deposits of the Tulameen and Quesnel rivers of British Columbia, the output was derived from the copper-nickel ores of the Sudbury district.

It is reported that Finland has ordered the first unit of the projected submarine flotilla. The contract was given to the Vulcan firm established in Finland, which co-operates with German and Dutch shipbuilding interests. Several British, French, Italian and Scandinavian firms sent in tenders. The submarines will be of German design.

The Calcutta Corporation has adopted a scheme for a more efficient drainage of the city at a cost of nearly Rs. 2 crores. The scheme includes the construction of a new pumping station off Ballygunge, which will be the corner-stone of the whole work, as it will help to drain a large portion of the city now practically undrained and often water-logged during the rains.

At Paranaguá, the chief seaport of the State of Paraná, situated on the southern shore of the bay of the same name and about 9 miles from the bar of the main channel, a wharf 500 m. long is about to be constructed. On its completion some of the larger vessels visiting Paranaguá will be able to dock. Few engineering difficulties are likely to be encountered, the bay being comparatively shallow.

The operation of completing the new Western Union permalloy cable between England and New York was successfully completed on the 5th inst., when the final splice in the Bay Roberts–New York section was made. The shore end in this country was landed at Sennen, Cornwall, on May 26th last. It is hoped to put the cable into full use within the next few weeks, after the necessary preliminary tests have been made.

The Governments of Mexico and Cuba have entered into a reciprocal arrangement for the connection of their respective telegraph systems by wireless and the institution of a transmission service for public and private purposes. All messages must be transmitted in Spanish, no use of code being permissible. The revenues derived from the services are to be divided equally between the two States, and accounts are to be kept in United States currency.

Drainage and road-building operations at "the Brook Kishon" have been begun at different points of the Haifa Bay area between 600–700 Jewish workers being engaged. Work has started on a road linking up Haifa with Acre in all weathers. This is the first of a network of roads to be developed in the Haifa Bay area. The Fuara spring is being dammed, so that the stream will be diverted into other channels, with the result that a vast area, now a malaria-breeding swamp, will be drained. Since March work has also been proceeding on the damming of the streams issuing from the Kishon. These improvement works will cost between £40,000 and £50,000.

We are informed that the Daniel Guggenheim Fund for the Promotion of Aeronautics has approved a grant of 5000 dollars to the Royal Aeronautical Society to enable it "more easily to continue its splendid contributions to the aeronautical science of the world." It is hoped that this grant will stimulate the growth and strength of the Society to such a point that within a short while financial assistance from without will be unnecessary. This donation to the funds of the Society comes at a time when financial assistance is urgently required, so that the Society can extend its present activities and carry out the projects which it has in view and which have been held up by lack of funds.

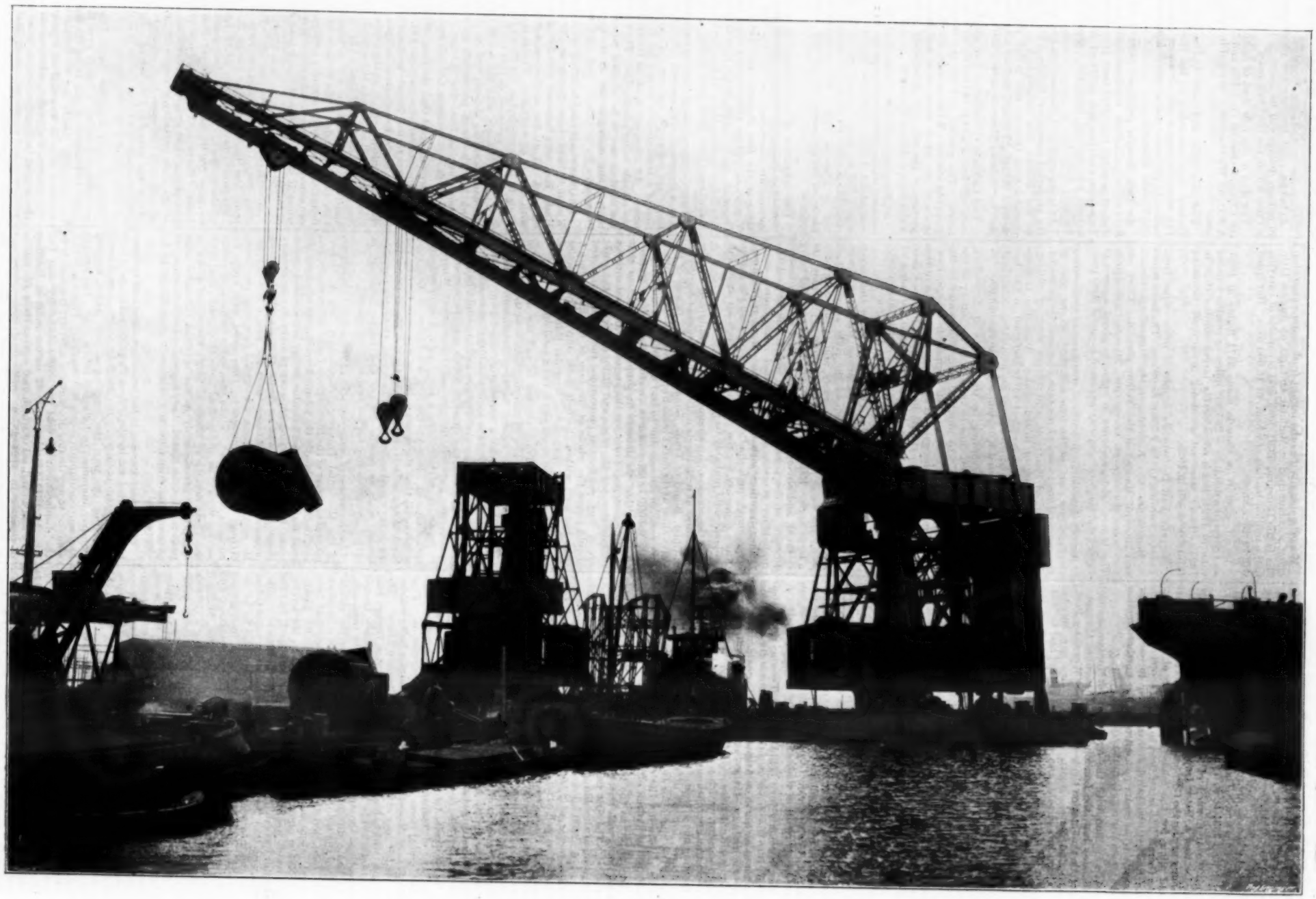
About 75,000 tons of iron ore is lost yearly in the Birmingham, Ala., district in the form of flue dust escaping from the blast-furnaces, states the Bureau of Mines, Department of Commerce, which has conducted a study of the subject. The flue dust losses in this district will average 250 lb. per ton of pig iron produced. On the basis of the present rate of pig iron production, the annual loss of flue dust exceeds 300,000 tons. The iron content of the dust probably averages 25 per cent., and the loss of iron from this cause thus amounts to about 3 per cent. of the iron mined in the district. By the use of magnetic concentrators of various kinds, it is considered that much of this loss can be prevented.

The *Berliner Tageblatt* learns from Belgrade that the question of building a bridge over the Danube from Belgrade to Pancevo is now being discussed by the Yugoslav Government, which has to decide whether or not the contract is to be awarded on reparations account. As is well known, the bridge, when constructed, will be one of the largest in Europe, for its total length will be about 3 kiloms., and its weight about 30,000 tons. For several months uninterrupted negotiations have been carried on in Belgrade between the Yugoslav Government and a group of German engineering firms, headed by the Krupp and Klönne concerns and the Dresdner Bank regarding the construction of this bridge. The Government has been requested by some circles to invite public tenders for the construction of the bridge and not to negotiate with the one German group only.

200-TON FLOATING CRANE FOR THE PORT OF LE HAVRE

WERF GUSTO, FIRMA A. F. SMULDERS, SCHIEDAM, HOLLAND, ENGINEERS

(*For description see page* 315)



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TWO-PAGE SUPPLEMENT—THE PROPELLING MACHINERY OF THE HIGH-PRESSURE TURBINE STEAMER KING GEORGE V.

THE ENGINEER.

SEPTEMBER 17, 1926.

Interatomic Forces and the Strength of Metals.

IT is probably no exaggeration to say that the most important problem of scientific metallurgy awaiting solution at the present moment is the discovery of the fundamental cause of strength and elasticity in metals. Broadly regarded, the solution of this problem may be held to provide the motive, unexpressed or otherwise, of all metallurgical researches, however remote they may appear from each other. With its solution we would at least be placed in a position to determine from first principles the answers to many questions which to-day have to be sought, each one separately, by way of a specific investigation. Many attempts have been made to solve the problem. So far little real progress has been made, but the signs are encouraging, and it may reasonably be anticipated that not many years will pass before the accumulating knowledge of the metallurgists will provide us with a basis on which to build a sound theory explaining the fundamental cause of strength and elasticity in metals. At present the facts gathered on the subject are multitudinous and very largely unco-ordinated, but with the rapid development of the method of analysing metals by means of X-rays and with the widely significant results of experiments conducted on specimens consisting of single crystals as initiated by Professor Carpenter and Miss Elam, and being continued by many others, we should in the not distant future be able to view the problem in a new and bright light and advance a considerable way towards the elimination of guesswork and assumption from its solution. For the time being pure guessing and unsupported assumption are liberally indulged in, even to the extent of adapting well-established physical laws in order that "theory" may be made to fit with the results of practical experience. It may be laid down as axiomatic that no solution of the problem is likely to command general acceptance unless it can be squared with the established facts of physical science as a whole. Any theory which may fit the metallurgical aspects of the problem, but which fails to join up without discontinuity with our existing knowledge of non-metallurgical phenomena, should not be rashly advanced.

In the present state of our knowledge we have no basis to proceed upon other than the belief that the fundamental cause of strength and elasticity in metals resides in the existence of interatomic force between the ultimate particles of which they are composed. Are these forces attractive or repulsive, or both, and what is the "law" governing their magnitude? In these questions we have the keynote to the problem as at present it appears to us. Portions of matter at sensible distances apart invariably attract each other in accordance with the well-established inverse square law, except when they are magnetised, in which condition, while the inverse square law still holds, they may either attract or repel other portions according to the polarity of the magnetisation. It can readily be shown to be a mathematical fact that any form of universal radiant influence issuing from matter will give an inverse square law of the Newtonian form if the amount of influence radiated and intercepted by a body is proportional to its mass. If the inverse square law is departed from the influence is not a radiation of any readily conceivable kind. From planetary masses at planetary distances apart down to small terrestrial bodies of a few pounds separated by a few inches the inverse square law of attraction has been definitely established as a physical fact. Yet it is true that Newtonian attraction between the atoms cannot explain the most elementary facts concerning strength and elasticity in metals. Below a certain neutral distance apart the atoms must repel each other in order that we may account for compressive elasticity and above the neutral distance they must attract each other. They must repel each other below the neutral point with a force that increases as the distance apart is diminished. Above the neutral point the attraction must increase as the distance apart becomes greater up to a limiting distance. Beyond the limiting distance the attraction must fall off and settle down into conformity with the law of "universal gravitation." These are the facts which our observation of the behaviour of metals in conjunction with our established knowledge of terrestrial and solar mechanics demand us to recognise in framing any theory of the cause of strength and elasticity. They seem irreconcilable among themselves, but in theory at least they are not so. Investigation in many diverse fields points to matter being composed of a congeries of positive and negative electrically charged particles, or, to speak more modernly, of positive and negative particles of electricity. With such a constitution the resultant force across an interface in a body must be the resultant of a large number of attractions and a large number of repulsions. In the normal unstrained state of the body the attractions and repulsions balance. Under compression the increased repulsions outweigh the increased attractions and a force tending to make the body recover the neutral state is developed. Under extension the diminution of the repulsions proceeds more quickly than the diminution of the attractions, with the result that the net force up to a certain point is an increasing attraction, and beyond that point an attraction which decreases as the relative effect of the repulsions diminishes. It would seem an easy matter to explain strength and elasticity on this basis. Qualitatively it is so, but when we pass to a quantitative study we at once encounter difficulties of a first-class order. While the "law" of the repulsions and attractions is, on the hypothesis, of the inverse order, it seems impossible that it can be of the inverse square order or that the index for the repulsions can be the same as the index for the attractions. In Professor Honda's paper before the Institute of Metals, reprinted in our issue of September 10th, it is stated that many of the properties actually observed in a specimen composed of sodium or potassium chloride can be quantitatively explained if the index of the inverse law governing the repulsions is taken at 9 and that of the law governing the attractions at 7. It is difficult to believe that the two indices can be other than equal. They are equal in the case of magnetic attraction and repulsion. If in the case of interatomic forces the indices are unequal, a negatively charged particle could not neutralise an equal positively charged particle placed beside it; the pair would attract all other particles, positive or negative, at all distances. It is difficult, too, to believe that the inverse index can be 7 in the case of the attractions. The gravitational attraction between the broken halves of a test specimen is inversely proportional to the square of their distance apart. Continuity demands that the net force between the parts just before the break occurs should be settling down to the same law and not to a seventh power law, the final condition according to the view expressed by Professor Honda. Most difficult of all is it to believe that the indices are not 2 in both cases. If they are not 2, neither the attractions nor the repulsions can be supposed to originate in a simple uniform radiation from the particles proportional in amount to their masses, but must be traced to some influence which is clearly not only very complicated, but is different

in some fundamental respect as between positive and negative particles. Reasoning on these lines we must favour the opinion that the index is 2 both for the attractions and the repulsions. If, however, we adopt this value we destroy the quantitative agreement mentioned by Professor Honda and, it must be confessed, raise fresh fundamental difficulties of which an inversion of the net attraction and the net repulsion relatively to the neutral point may be one.

The problem is not to be solved by assigning particular values to indices and other factors for no more reason than because the figures inserted permit certain observed facts to be explained. To do so is to proceed on an unscientific basis and may prove widely misleading. The observed facts which it is sought to explain may have little or nothing to do with the precise nature of the interatomic forces, for it is as yet by no means certain how far crystalline formation and other features of practical metals modify the phenomena attributable to the existence of the fundamental attractions and repulsions. Professor Carpenter's experiments on single crystals of aluminium and those of other investigators studying single crystal specimens of various metals should serve to caution us in this respect. The strength of such specimens may rightly be regarded as the resultant of the interatomic attractions and repulsions, and it is only to the results of tests on single crystal specimens that any quantitative comparison with atomic theory ought to be applied. These results are strikingly different from those obtained from ordinary poly-crystalline specimens. The tensile strength is generally considerably lower and varies from specimen to specimen through a very wide range according to the orientation assumed by the crystal composing the specimen. From aluminium showing when tested in the ordinary state a strength varying from specimen to specimen between 4·5 to 4·7 tons per square inch, Professor Carpenter produced single crystal specimens with strengths varying from 2·80 to 4·08 tons. Again, while the extensions of the normal specimens ranged from 36 to 38 per cent., the single crystal specimens showed extensions varying from 34 to 86 per cent. The methods of fracture were, too, totally different. An originally round bar, instead of showing the usual cup and cone fracture of circular cross section, drew down in the single crystal state to an elliptical section and fractured with almost a knife edge of a length practically equal to the original diameter of the bar. In the Brinell test a round ball failed always to produce a round impression, but in nearly every case produced a substantially square indentation. These and other strange phenomena serve to show that many of the familiar properties of metals are profoundly influenced by the poly-crystalline character of their structure. To metals with this structure calculations and theories based simply on the nature and magnitude of the interatomic forces cannot be applied. Such calculations and theories apply only to single crystal specimens concerning the curious and unusual properties of which we are only beginning to gain knowledge. When the fundamental principles governing the strength and elasticity of single crystal specimens have been worked out and explained it will still remain to undertake the probably more formidable task of extending the explanation to cover the cases of ordinary poly-crystalline metals. Then, and not till then, will we be able to apply the knowledge gained to practical ends.

Locomotive Valve Gears.

THE ever-increasing size of steam locomotives to meet the demands imposed by present-day traffic is causing the attention of designers to be directed to the question of ways and means whereby the steam generated may be used with more economy. Any improvement in the steam rate per horse-power developed naturally offers the advantage that relatively small engines would be able to perform duties usually assigned to those generally larger and heavier, and we need not emphasise the desirability of avoiding the necessity of largely augmented size and weight whenever higher sustained powers are required. Resort to higher working pressures may solve the problem in part, but in any event the better employment of the steam, be it at 350 lb. or 125 lb., is matter of serious moment.

It is, of course, true that on various occasions different forms of valves and motion have been experimented with, but on the whole locomotive engineers seem to take it for granted that some form of link or radial gear operating a sliding valve is the only arrangement to be practically considered. Yet it is well known that such gears in their various well-known forms have from their very nature somewhat serious shortcomings if extreme economies in steam consumption are desirable. They have survived owing to their simplicity and reliability and in spite of their defects. We may, in order to advance our argument, refer shortly to the action of ordinary link gears. It is well known that the periods of admission, expansion, exhaustion and compression are governed by the valve travel, the shortening or lengthening of which alters the relationship between the valve events and the position of the piston. Strictly, the locomotive, to be really flexible with economy, must be able to operate between a wide range of cut-offs, ordinarily between, say, 80 and 20 per cent., and even less in the case of high-speed express engines. To achieve such operation means adjustment of the valve travel, which must be shortened for early cut-offs; this, of course, means in turn restricted port opening, early release and early compression, and unless great care is exercised the last named may become excessive and cause heated crank pins. In practice this is the chief trouble, and to overcome it recourse is made to large clearance volumes, the very thing we have from infancy been taught to avoid. Naturally, there must be some clearance, and it is quite possible to keep it down to about 6 or 7 per cent. when designing the port connections and so on; but with clearances of such small dimensions early cut-offs in the interests of low steam rates are not possible owing to excessive compression, and usually it is found that 12 or even more per cent. is required. The well-known 4–6–0 engines, Class P.8, on the German State lines, designed by Garbe, have 13 per cent. clearance. Another feature of moment is the time of release. For early cut-offs it occurs proportionately early, with the result that the expansion curve is restricted and exhaust takes place at a relatively high pressure. If for *any* cut-off we could release at, say, 80 per cent., instead of at about 60 per cent., for a 25 per cent. cut-off we should develop more power per unit of steam owing to the longer expansion period and the lower back pressure. But to achieve that object it would appear to be necessary to separate the steam and exhaust valves, and since locomotive designers are not prepared to consider two piston valves for each cylinder, nor valves of the semi-rotary or Corliss kind, there remains for consideration but one kind of valve—the double beat or "poppet" valve. With it and cam operation the problem as far as steam distribution is concerned becomes comparatively simple. Moreover, since valves of this kind require little effort for their operation, lightly constructed driving means may be employed, and if a rotary cam gear or an oscillatory cam arrangement with separate steam and exhaust valve operation be accepted, the way is open to a refinement in valve gears and the attainment of higher economies becomes possible.

Our readers are well aware that the poppet valve for locomotives is by no means new. Both Lentz and Caprotti have produced valve systems embracing the special features which have been mentioned, and we feel safe in saying that experience so far gained points to the fact that the combination can with safety be applied to the locomotive. The Lentz gear has been in use on certain continental lines for a long time now, and Mr. Gresley has had an engine so equipped for more than a year. Furthermore, we are given to understand that Sir Henry Fowler is fitting a locomotive with the Caprotti arrangement already in use on the Italian State lines. These experiments are of very great interest. The crux of this question is the elimination of high clearances by modifying the compression periods with varying cut-offs and a constant release point. That that object can be obtained by cam-operated gears is scarcely open to doubt, yet it must not be too hastily assumed that the "poppet" valve gear presents an immediate solution of the problem. In locomotive work, possibly to a greater extent than any other kind of mechanical engineering, nothing short of a prolonged test under service conditions can be regarded as conclusive. Coal economy may be more than counterbalanced by upkeep costs, or unreliability may wipe out all the advantages of the best devices. Yet on the other side of the account we have to remember that by lightening locomotives and improving their balance there would be less wear and tear on roads and bridges. Here again, as we have so often insisted, the road and the engine must be considered together. The Caprotti gear has proved successful from the locomotive engineer's point of view in Italy and the Lentz gear in Austria, but British engineers prefer to make their own tests under their own conditions, and much hangs therefore upon the results achieved by the L.M.S. and the L.N.E.R. engines. If they show an actual economy, all things considered, an equal trustworthiness and equal facility of handling with existing gears, then we may expect to see the poppet valve firmly established as a feature of locomotive design. But the tests must be long and exhaustive before a decision can be reached.

Iron and Steel Institute.

No. III.*

Visits to Mines and Works.

WITH the tours to the mining and iron and steel manufacturing districts of Sweden came an opportunity of learning something at first hand of these industries in a country where iron at least was manufactured even before any regular historic records were kept. There is definite evidence that iron was produced in Sweden more than 2000 years ago. That so early a start was made is due in great measure to unrivalled natural resources. Iron ore was abundantly distributed in the lakes and marshes, and the forests supplied the fuel necessary for the process of reduction. Relics of the early iron workers exist to-day in the form of small furnaces of simple type, and slag heaps. During the period when charcoal was the only fuel available, the Swedish industry occupied a very favourable position, and this advantage, added to the possession of ores of great purity, and long experience in the manufacture of iron, gave the Swedish product a reputation for quality which has never been surrendered, although in magnitude of output the iron and steel industry has had to yield pride of place to that of other countries. Quality of product has therefore been the chief object of Swedish manufacturers, and for certain classes of high-grade materials they hold, and should continue to maintain, a sure grip on the world's markets. During a recent period ample use has been made in the operation of the iron and steel industry in Sweden of hydro-electric power. The output of the existing works consists mainly of high-class pig iron, low in sulphur and phosphorus, charcoal wrought iron—which is a monopoly of the Swedish industry—special makes of Bessemer steel and open-hearth steel, and crucible steel. A feature is also made of rolled, forged and cast materials.

The two tours were well arranged to enable those who made the journeys to see as many phases of the mining and metallurgical industries as possible in the three days allotted to this section of the programme. Both excursions presented definite attractions, and it was difficult to make a choice, and the selection was in most instances determined by minor considerations. The same arrangements were made for the two tours. Those taking part in them joined special trains at Stockholm, which were provided by the State Railway Organisation and by the private companies concerned, and the trains served as travelling hotels until the parties returned to the Swedish capital. Meals were, however, provided by the various companies and firms whose works were visited, and who proved very hospitable hosts.

A Famous Mine.

One excursion included the Grängesberg mine, Domnarfvet Iron and Steel Works, the Falun mine and museum, Hofors Steel Works, Sandvik Steel Works, and Dannemora mines and works. The party left Stockholm on the night of Sunday, August 29th, and reached Grängesberg early on the following morning.

The mine has had a long history, and it is known that the ore deposits were worked as early as 1584. Until the end of the nineteenth century the somewhat primitive open stoping method of mining persisted, but the system now in operation is a modification of the American system of slicing, adapted to suit the hard Swedish ores. The Grängesberg field is the principal part of an almost unbroken chain of ore deposits extending from Lake Norra Hörken to Gräsberg for a length of about 20 miles. The principal deposits worked are in the so-called Export Field, which contains both a finely grained magnetite ore, generally containing 62 per cent. of iron and 0·8 to 1 per cent. of phosphorus, and a hematite ore, containing from 0·07 to 0·30 per cent. of phosphorus. Since 1900 all mining is carried out underground, the maximum depth of the workings being 190 m. The ore is loaded in trucks of 3 tons capacity, and the trains are hauled by electric engines to the foot of the shaft, dumped into a pocket holding about 3000 tons, and delivered thence into smaller pockets having the same capacity as the skips into which the ore is transferred for raising to the surface. The whole of these operations are performed by mechanical power, accumulated by compressed air. The amount of rock raised is from 1700 to 1800 tons per shift. The ore as raised is dumped into pockets in the shaft head, is crushed and graded, the magnetic ore separated from the non-magnetic, and the waste removed. It is then delivered direct to railway trucks for transport. The quantity mined in the Export Field down to the end of last year was

* No. II. appeared September 10th.

25,885,000 tons, but the total amount of ore in the Grängesberg mine, down to a depth of 500 m., is estimated at 130 million tons. There are therefore immense reserves.

DOMNARFVET AND FALUN.

Visitors proceeded from Grängesberg to the Domnarfvet works, which belong to the Stora Kopparbergs Bergslags A.B. The Company also owns the Falun mine, an inspection of which was included in the programme. The Domnarfvet iron and steel plant was laid out during comparatively recent years for using water power from the adjacent river Dalälven, and with the completion of the last station the company possesses about 90,000 turbine horse-power. The electric furnaces date from the year 1914. The blast-furnaces have an output of about 25,000 tons a year, and the electric smelting plant a capacity of 25,000 tons of pig iron a year, but the whole subject is being carefully studied, and with the enlargement of the hydro-electric plants and the technical improvement of the electric process, it is hoped to produce all the pig iron in electric furnaces. The electric steel plant comprises one furnace of 5-ton capacity and one of 20-ton capacity. The larger furnace is used partly for the melting of scrap and partly for the refining of the charcoal Thomas pig iron, and the small furnace for special charges for the steel foundry. The total capacity of the steel plant of the whole works is 100,000 tons of finished material a year. Domnarfvet takes from the power station about 42,000 electric horse-power per year, of which the electric pig iron furnaces require 25,000 horse-power.

The Falun mine is claimed to be the oldest industrial enterprise in Sweden, a document relating to the owning company, bearing a date towards the end of the thirteenth century, and bearing evidence that copper mining was carried on at a much earlier date. In the seventeenth century the mine was the largest producer of copper in the world, and Sweden one of the Great Powers of Europe. The mine is now worked chiefly for iron pyrites, of which the yearly production is about 70,000 tons. It is used in the company's pulp mills and sulphuric acid plant. The museum at Falun is filled with exhibits which illustrate the history of the mine. One room contains models constructed by the famous Swedish mechanic Christopher Polhem, and ancient Swedish iron making is represented in the museum by models of furnaces and samples of iron. A display is made of blast-furnaces from the old timbered shaft type to the modern electric furnace. The old Swedish refining method, the German forge, the Walloon forge and the Lancashire forge are shown by models.

HOFORS, SANDVIKEN AND DANNEMORA.

The Hofors works are the oldest in the province of Gästrikland, having been founded in the first half of the seventeenth century, and the plant remained in the possession of one family for 200 years. When it passed into the hands of the present owners, a policy of concentration was adopted, and water powers were secured. It is stated that the rolling mills installed in 1896–97 were the first in the world to have the all-electric drive. In 1916 the works were acquired by the Skefko ball-bearing interests, which desired to make sure of adequate supplies of the high-grade material required in the manufacture of ball bearings.

The Sandvik works, which were described and illustrated in THE ENGINEER of April 23rd, 1926, at one time made a special feature of rolling railway tires, and were amongst the first to undertake the cold rolling and the hardening of band steel. At a later date the works commenced the manufacture of hot rolled weldless tubes, which is still an important part of the output. The new laboratory for physical and chemical research is regarded as one of the best equipped metallurgical laboratories in Sweden. The management has given great attention to the social welfare of employees, and has built schools, churches, theatre, lecture hall, and hospitals, and has provided sport grounds and parks. A visitor to Sandviken is much impressed with all that the company has done in this connection.

The Dannemora mines and works constitute an important enterprise. The mines, which contain a very high-grade ore, have been worked since the end of the fifteenth century, originally, however, for silver, and for iron ore since about 1530. In the year 1545 a large company, of which Gustavus Vasa was a shareholder, was formed, and the Royal house maintained its interest in the undertaking through several reigns. This interest in Dannemora by the reigning sovereign is a feature of the Swedish industry as a whole, which has been maintained down to the present day. It is a tradition that the King should show the keenest interest, both as shareholder and as patron, in the iron and steel industry. Dannemora is not an isolated case; it is merely one outstanding example. Louis de Geer was also one of those who were responsible for the development of Dannemora, but he and those who followed him in the management have had to fight the flood danger arising from the fact that the mine has always been exposed to the intrusion of water from the adjacent lake. Pumping, the building of embankments and ditching, and attempts to lower the level of the lake, have all been tried as remedies, and the trouble may now be regarded as overcome. Preparations for the sinking of a new level in the mine at a depth of 300 m. are being made. The yearly production of the mines is estimated at between 50,000 and 66,000 tons.

The Dannemora works, which were at one time in the possession of the State, were established as early as the sixteenth century. De Geer, who was in control of the works as well as the mines, was responsible for the introduction of the Walloon method of forging into Sweden, and raised the reputation of the establishment to the point when large orders were obtained from England. The Osterby plant is the newest which the company possesses, having been erected during the post-war period. The latest addition is the laboratory, brought into service during the current year, and equipped with the latest type of apparatus for the testing of iron and steel products. The saw blade and machine knife factory are now being enlarged to meet the increasing demands on this department, which was only established six years ago. At Gimo the company has erected saw mills. The Dannemora works also carry on extensive farming operations, having a holding of 440 square miles.

AN IMPORTANT INDUSTRIAL ENTERPRISE.

Those who took part in the alternative tour also had a glance at some of the leading works. The most important undertaking included in the programme was the Uddeholms A.B., which is quite justly claimed as one of the big businesses of Sweden. It would be true to affirm that the history of Uddeholms over a period of more than 200 years is the history of the province of Vermland. The company's estates now aggregate more than 700,000 acres of land, and include forests, iron ore mines and water powers. Steel and tube mills have been erected, a considerable mileage of railways has been constructed to link up the works with the main railway system, and the company has a fleet of cargo steamers engaged in the export trade. Uddeholms is therefore a good example of a self-contained organisation. It was Bengt Gustaf Geijer, who in the early years of the eighteenth century laid the foundations of the present enterprise. The business remained in his family for a century and a-half, when it was converted into a company. This change from private to company ownership was associated with fresh developments, and under Jonas Wærn the Munkfors works were added and other measures adopted to enable the company to take advantage of the repeal of the law forbidding the export of pig iron, a legislative act carried out in 1846. With the entry of the company into the export trade, a crisis in transportation arose, and was only solved by the building of a private line 42 miles in length. This line has since been extended and converted to electric operation. It was at Munkfors that early experiments were made with the Siemens-Martin process, with various types of gas producers, and that important work was done in solving problems associated with the electrical blast-furnace.

DIRECT STEEL PROCESS.

This keen desire to take a leading part in the technical development of the iron and steel industry still persists in the management at Uddeholms. At the Hagfors works of the company an attempt is being made to operate on a commercial basis the Flodin-Gustavson process of obtaining fluid steel direct from the ore. A new 3000-kilowatt capacity furnace is now in regular operation, and has made a large number of melts. It has an output of 30 tons per twenty-four hours, and it is claimed that the cost of producing fluid steel is, in current consumption, no greater than that of producing pig iron in the electric furnace. A feature of the new product is the low carbon content, the figure given being 0·03 per cent., which should interest manufacturers of stainless steel. The mechanical properties of the material are stated to be very good, ranging up to 27 tons tensile, with an elongation of 28·8 per cent in 2in. These figures vary with the carbon content. About twenty tappings of the new furnace have been made. In addition to the works mentioned, the company owns the Storfors and Nykroppa tube and steel mills, and the Skoghall saw mills and sulphite plant. The chemical industry is indeed well represented in Uddeholms' activities. The total value of the products sold last year was 37,000,000 kroner, and the company employs about 8000 workers.

Degofors, which was included in this excursion, has had a long history, a forge having been set up in about 1654, and a second in 1666. The present owing company, the Strömsnäs Steel Works Company, represents an amalgamation of interests. A policy of extension has been adopted, and even at the present unfavourable time for capital expenditure, a large new Siemens-Martin works and a modern heavy mill are being erected.

OTHER WORKS.

Bofors is noteworthy for the association with it of Paul Linnertson Hosman during the second half of the seventeenth century, and for the stimulus given to the business at the end of the nineteenth century, when Dr. Alfred Nobel, the authority on explosives, acquired a large interest in the company. Following his association with the works, Bofors was laid out for the manufacture of guns and other war material, and it is the only munition-producing steel works in Sweden. Besides producing guns and projectiles, a feature is made of ships' anchors, propellers, davits, solid and hollow marine engine shafts, and other articles for which good material must be available. One of the latest additions to the list of productions is small marine Diesel motor parts. A fact which has been of great importance in the development of the undertaking is the presence in close proximity to the works of rich ore deposits, wood for charcoal burning, and water power. Additional hydro-electric power is now being developed for an extension of the business on the electro-metallurgical side.

The present works at Hellefors which were inspected are the result of an amalgamation of small concerns such as Hellefors, Sikfors and Sälvenfors. Here, again, the possession of high-quality iron ores and charcoal are factors which made for success. Owing to a fire eight years ago, the works at Hellefors have been partially rebuilt, and are among the best equipped in Sweden for making high-grade steel. Annealing is carried out in specially designed automatically controlled furnaces. An electric furnace of the Moore type is now under construction. The feature of the output is billets of carbon and alloy steels. In addition to its manufacturing activities, the company is a large producer and distributor of electric power.

Fagersta was the other steel works included in this excursion. The situation of the plant is not only excellent from the point of view of export and internal trade, but is in a beautiful setting in the valley of a river in the iron-making district of Norberg. When iron was first produced here is uncertain, but there is in existence a document, dated 1611, which conferred certain privileges on Fagersta as an ironworks, although it is probable that at that time the plant consisted only of a small forge with one hearth and one hammer. Great progress was made during the period 1892–1903, when J. A. Brinell was chief engineer. It was here that his hardness testing method was evolved, and his first machine can still be seen at the works. He was succeeded by Mr. Axel Wahlberg, who is now the chief engineer of Jernkontoret. The progress initiated during the Brinell *régime* has been sustained, and the new blast-furnace plant may be regarded as one of the most modern in Sweden for making charcoal pig iron. The Bessemer method of manufacture was given up before the end of last century, and only open-hearth steel is now produced. The crucible steel works are equipped with two electric furnaces. The capacity of the Siemens-Martin furnaces is about 60,000 tons of ingots a year.

With the return to Stockholm of the members taking part in these visits, the autumn meeting of the Institute came to an end. There was, however, a pleasant unofficial function on the eve of the departure of members of the Institute from Stockholm, in the form of a dinner given by the President and members of the Council to some of the Swedish hosts of the Institute. Advantage was taken of this gathering to express the indebtedness of the Institute to those who had organised the meeting. While it was disappointing that for reasons connected with the industrial situation in Great Britain the number of members who were able to make the journey to Sweden was smaller than had been anticipated, the meeting can be regarded as having been a great success. It was well organised by the Committee, of which Mr. E. Kinander was chairman and Mr. A. Grabe honorary secretary, and their efforts received that co-operation from Mr. G. C. Lloyd, the secretary of the Institute, and his staff which made everything work very smoothly.

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A BRITISH SUBMARINE DEPOT SHIP.—It is announced by Vickers Ltd. that the firm has received from the Admiralty an order for a large submarine depôt ship. The main propelling machinery will consist of twin-screw double-acting internal combustion engines, which will be manufactured at Barrow-in-Furness from British materials under licence from the M.A.N. Company.

The Assembly of Planetary Gears.

By HENRY E. MERRITT, M.Sc. (Eng.).

In designing planetary gear sets, attention must be given to the question of whether the numbers of teeth in relation to the desired number of planets are such that the gears will assemble with all the teeth meshing in the correct manner. Surprising as it may seem, cases are not unknown in which neglect of this apparently obvious precaution has led to considerable trouble.

When the subject is superficially examined certain cases stand out as obviously permitting correct assembly, such, for instance, as that in which the number of teeth on every member is a multiple of the number of planets. Further examination, however, reveals the interesting result that many combinations are possible which at first sight do not appear to permit assembly, and it is the purpose of this article to discuss these cases and to present simple rules which may be applied to every type of planetary gear.

Simple Planetary Gears.—We will consider first the simplest planetary gear, represented in Fig. 1. In this diagram A is the sun wheel (or primary concentric gear) having T_a teeth, B is the planet having T_b teeth, D is the internal wheel (or secondary concentric gear) having T_d teeth. Also let N be the number of planets desired.

The principle employed in analysing the conditions may be explained as follows :—

In the position shown in Fig. 1 it is understood that the teeth of the gears A, B and D are correctly in mesh with each other. It is required to find whether another similar planet B′ will simultaneously mesh correctly with A and D when in the position indicated by the dotted circle. There are, of course, a large number of positions which will fulfil this requirement, but convenience in design and manufacture requires that the angle θ shall divide exactly N times into one revolution.

Now let the sun wheel A be fixed and only one planet (that at B) be in mesh. Then let B be rolled round A with its predetermined planetary motion in the clockwise direction. This will cause the internal gear D to rotate clockwise, and when the planet B has reached the dotted position B′ corresponding to the initial position of the adjacent planet, it must be possible for a new planet to be dropped exactly into position in the original place of B. Hence, since A and the initial centre of B are fixed, it is only necessary that the periphery of D shall have rotated an exact number of pitches in order to make the final and initial conditions exactly similar.

The above can be expressed in terms of T_a, T_b, T_d, and N as follows :—

Using the conventional treatment for the velocity ratio of a planetary system, let the whole system make one complete revolution in the clockwise direction. By rotating A through one revolution in the anti-clockwise direction, the axes of the planets being fixed in position, D will arrive at its final position, corresponding to one revolution of the axis of the planet B about A.

Thus for one revolution of the axis of B, D will make

$$1 + \frac{T_a}{T_d} \text{ revolutions.}$$

If there are N planets, B will be required to make $\theta = \frac{1}{N}$ revolution, when D will make

$$\frac{1 + \frac{T_a}{T_d}}{N} \text{ revolution.}$$

Now this must be an exact multiple of the angle $\frac{1}{T_d}$ revolution subtended by adjacent teeth on D, hence we have

$$\frac{1 + \frac{T_a}{T_d}}{N} \div \frac{1}{T_d}$$

must be a whole number, *i.e.*,

$$\frac{T_a + T_d}{N}$$

must be a whole number. Thus we have the simple rule, of general application, that *the sum of the teeth on the sun and internal gear must be exactly divisible by the number of planets.* The number of teeth on the planets does not in this case enter into the question. Thus, to take concrete examples, a gear having three planets, where $T_a = 15$ and $T_d = 45$, will obviously assemble without using the formula, although checking by means of the rule we have

$$\frac{15 + 45}{3} = 20 = \text{whole number.}$$

It is not so obvious, however, that with three planets, $T_a = 13$ and $T_d = 47$, the unit will still assemble correctly. That it will do so is shown by using the rule, however, when

$$\frac{13 + 47}{3} = 20 = \text{whole number, as before.}$$

Simple Bevel Planetary Gears.—The above method and rule may be applied without alteration to any three-gear planetary, such as a Humpage gear, a bevel differential, and the like (Fig. 2). The rule may be more concisely and exactly worded as follows :—"The sum of the teeth on the concentric gears must be exactly divisible by the number of planets."

It should be noted that this rule does not apply to the "Marlborough wheel" gear, which is virtually a compound planetary gear.

Compound Planetary Gears.—In a compound planetary gear, Fig. 3, the planet consists of two toothed gears, each of which meshes with a concentric gear. Let

N = number of planetary spindles,
T_a = teeth on primary concentric gear A,
T_b = teeth on primary planet gear B,
T_c = teeth on secondary planet gear C,
T_d = teeth on secondary concentric gear D.

Following the lines of case I, one forward revolution of the complete gear and one backward revolution of the primary concentric gear will give to the secondary concentric gear

$$1 \pm \frac{T_a}{T_b} \cdot \frac{T_c}{T_d} \text{ revolutions,}$$

the plus sign being used if the concentric gears are internal and external respectively and the minus sign if both are either internal or external. Hence in $\frac{1}{N}$ of a revolution of the planet axes the secondary concentric gear will rotate

$$\frac{1 \pm \frac{T_a}{T_b} \cdot \frac{T_c}{T_d}}{N} \text{ revolutions.}$$

Now after this degree of rotation the secondary concentric gear may not have moved an exact multiple of one pitch, and yet assembly may still be possible. For in any given position of the primary concentric gear the primary planet may be placed in T_b different positions, and if H is the highest common factor of T_b and T_c, the secondary planet teeth can be adjusted by a vernier effect to occupy a number of positions varying from each other by $\frac{T_b}{H}$ of one pitch.

Hence the rotation due to $\frac{1}{N}$ revolution of the planet axes must be a multiple, not merely of $\frac{1}{T_d}$ revolution, but of $\frac{H}{T_b}$ times this amount, *i.e.*,

$$\frac{1 \pm \frac{T_a}{T_b} \cdot \frac{T_c}{T_d}}{N} \div \frac{H}{T_b \cdot T_d} = \text{a whole number}$$

$$\therefore \frac{T_b \cdot T_d \pm T_a \cdot T_c}{N \cdot H} = \text{a whole number.}$$

Hence we arrive at the general rule for assembly of compound planetary gears : "The sum (or difference) of the products of the numbers of teeth on the driving concentric and planetary and driven concentric and planetary gears must be exactly divisible by the product of the number of planet spindles and the highest common factor of the numbers of teeth in the planetary gears." The sum is to be used when the concentric gears mesh on opposite sides of the planet axes, and *vice versâ*.

As an example of the application of this rule Fig. 4 shows a compound planetary gear. In this gear

A = primary (driving) concentric = 12 teeth.
B = primary (driven) planet = 28 teeth.
C = secondary (driving) planet = 12 teeth.
D = secondary (driven) concentric = 35 teeth.
N = number of planet spindles = 2.

Then highest common factor of B and C = 4 and $\frac{12 \times 12 + 28 \times 35}{2 \times 4}$ is not an integer.

The gears would not therefore assemble. If, however, T_c be increased to 36 assembly is made possible. In this case

$$12 \times 12 + 28 \times 36 = 1152.$$

Dividing 1152 by the H.C.F. gives 288, and any number of planet spindles which divides exactly into this number could be used ; *i.e.*, each planet will assemble in 288 different positions for any given relative position of the concentric gears.

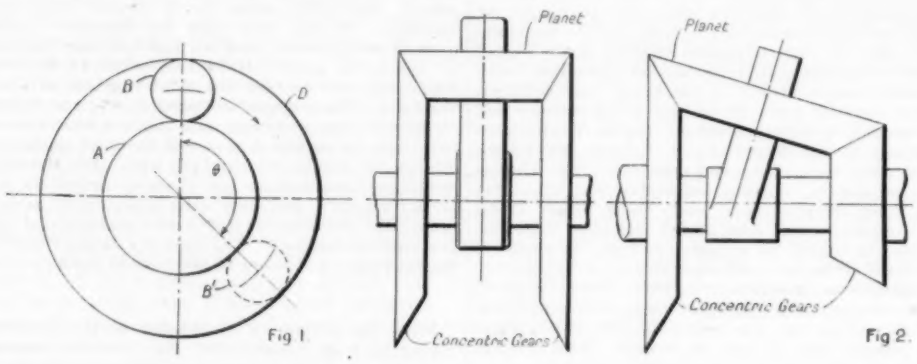


Fig 1. Fig 2.

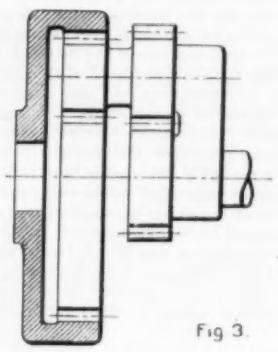


Fig 3.

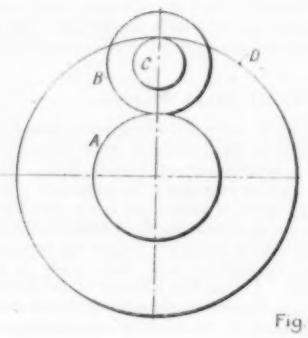


Fig 4.

THE ENGINEER SWAIN SC.

Connecting-rod Forks.

By THOMAS PETTY.

CONNECTING-ROD forks are frequently designed by setting out a form which, in the judgment of the designer, appears to offer good proportions ; its adequacy for the purpose then being investigated by determining the resulting stresses. The object of the present article is to describe a simple form of forked connecting-rod end which is easily machined, and a rapid method for its design, the character of which is synthetic as opposed to the tentative and analytic process above mentioned.

From the accompanying engraving, which shows the type of forked end referred to, it will be seen that the intrados U X V is of the circular shape which is usually suitable for steam engines and for single and double-acting Diesel engines with crossheads of normal design. The exterior of the fork is of plain conical form, connected at its lower end with the cylindrical body of the rod by a suitable fillet.

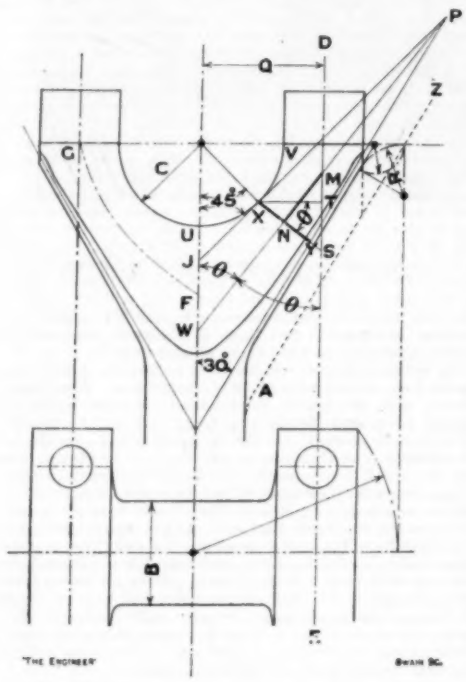
By a convention familiar to designers, the actual curved form given to the exterior of the fork in the process of turning is replaced as shown by the approximately equivalent flat side, in considering the stresses. The dotted line A Z, the position of which is determined by the geometrical construction given, indicates the extrados which must be adopted if the upper end is to be finished by plain taper turning only. Somewhat lighter proportions will usually be employed, in which case the extrados is rounded into the underside of the palm with a radius R, whose maximum value is obtained as indicated.

The dimensions of the palms, the position and radius C of the intrados and the line of action of the load D E are determined, of course, by the design of the piston-rod crosshead, and top end bolts and bearings, the position of the intrados being preferably arranged so that a ring spanner can be got upon the bottom piston-rod nut with the connecting-rod in place. The simplified method of rapidly determining the scantlings of the jaws of the fork, *i.e.*, of fixing the position of the conical extrados, which is now to be described, depends upon the principle of ascertaining the required proportions at an approximately located critical section of the jaw in a form which will ensure that the

stresses above and below the criticial section will, if anything, diminish. With normal proportions this condition, and a good form of forked end, will be attained by an extrados inclined at 30 deg. to the vertical, as shown in the engraving.

Owing to the curved form of the intrados the inclined beam formed by the jaw is not perfectly straight, its median plane having, in fact, the slight curvature shown by the line G F at the left-hand member. Strictly speaking, therefore, it should be dealt with by the treatment appropriate to initially curved beams. As a simplified and rapid procedure is the object sought, however, the ordinary methods applicable to straight beams will be adopted as a sufficient approximation.

A radial line at 45 deg. is drawn to cut the intrados at X. At right angles to this line and therefore tangent to the intrados at X draw J X P, meeting the extrados produced at P and including therewith an angle of 45 deg. — 30 deg. = 15 deg. Bisect this angle by the line W P, which makes an angle of 37½ deg. with the vertical and cuts the line of action of the load at M. Draw X Y at right angles to W P and cutting it at N. Then X Y may be taken as being approximately the section which experience shows to be the one above and below which the stress will diminish in forks of



normal proportions and with straight extrados at 30 deg. as shown, while N M is the arm of the section. Produce X Y to S and draw the horizontal X T. The stress at the section X Y is obtained by the following method, which probably will be understood more readily for the reason that it is somewhat roundabout. Let B = the breadth of the jaw, and for convenience in reference let

$$N M = L,$$
$$X Y = H,$$
$$X T = K.$$

Also note that the angles U W M, W M S and T X S are all equal to $\theta = 37\frac{1}{2}$ deg., and that

$$\frac{C}{Q}$$

$$X T = K = Q - \sin 45° C = Q - 0{\cdot}7071\,C,$$

and $X S = \text{Sec. } \theta\, K$

are all constant and are readily determinable from the dimensions in any particular case. The arm of the section $N M = L$

$$= \text{Cot. } \theta \times N S$$
$$= \text{Cot. } \theta \left(X S - \frac{H}{2} \right).$$

Let W be the load acting along the line D E.

Then the direct stress at the section

$$= W \left[\frac{\cos. \theta}{B H} \right]$$
$$= W \left[\frac{0{\cdot}7934}{B H} \right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The bending stress at the section

$$= W \left[\frac{6 \times \sin. \theta \times \cot. \theta \left(\sec. \theta K - \frac{H}{2} \right)}{B H^2} \right]$$
$$= W \left[\frac{6K - \left(6 \times \cos. \theta \times \frac{H}{2} \right)}{B H^2} \right]$$
$$= W \left[\frac{6K - 2{\cdot}3802 H}{B H^2} \right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The maximum stress at the section =

$$f = W \left[\frac{0{\cdot}7934}{B H} + \frac{6K - 2{\cdot}3802 H}{B H^2} \right]$$

$$= W \left[\frac{6K - 1{\cdot}5868 H}{B H^2} \right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and will be one of tension or compression according to the direction of the load acting along D E.

Transposing in (3) and solving the quadratic, we have

$$H = \sqrt{\frac{W}{Bf}\left(6K + 0{\cdot}6295 \frac{W}{Bf} \right)} - 0{\cdot}7934 \frac{W}{Bf}. \quad (4)$$

thus enabling the proportions of the jaw to be determined. The value of the stress *f*, calculated by the above method from the maximum combustion pressure in Diesel engines and the boiler pressure on the area of the H.P. piston in steam engines, for rods of ordinary mild steel, varies in general practice from 6000 lb. to 9000 lb. per square inch, the higher values being found in single-acting two-stroke cycle Diesel engines in which there is no stress reversal, and in four-stroke cycle engines of the same type in which the reversed stress has the low value corresponding to the inertia load from the moving parts. Flexural rigidity is the primary consideration in a part of this description, however, since the crosshead gudgeon bearings cannot be expected to work well and with complete freedom from overheating, especially in view of the high pressure per unit of area to which they are subjected, unless they are adequately supported by a relatively unyielding structure. Looked at from this standpoint and in view of the relative constancy of the modulus of elasticity, the stress to be allowed will be comparatively independent of the strength of the material employed, or the question of stress reversal in the case of a material with a high reversal limit, but will depend partly upon the general proportions of the forked end itself. Having regard to the necessity for stiffness, the writer is strongly inclined to advocate proportions which would be considered excessive by many designers, as they undoubtedly may be from mere considerations of strength alone.

As an example of the ready application of the method the following may be given :—

Forked end of connecting-rod for double-acting Diesel engine having cylinders 31½in. diameter.

Q = 14in.
C = 8¾in.
B = 12in.
W = say, 195,000 lb.
f = say, 6000 lb. per square inch
K = 14 — (0·7071 × 8·75)
= 7·813in.

$$\frac{W}{Bf} = \frac{195{,}000}{12 \times 6000} = 2{\cdot}71$$

Then from (4)

$$H = \sqrt{2{\cdot}71\ (6 \times 7{\cdot}813 + 0{\cdot}6295 \times 2{\cdot}71)} - 0{\cdot}7934 \times 2{\cdot}71 = 9{\cdot}33\text{in.}$$

Again referring to the engraving, the intrados and D E are set out in accordance with the given dimensions. A radial line at 45 deg. is then drawn meeting the intrados at X. From X a line is drawn at 37½ deg. below the horizontal and along it the distance H as determined above is measured, giving the point Y. A line at 30 deg. to the vertical through this point gives the equivalent flat side of the jaw, from which the line of the actual turned form is readily determined.

By suitable extension and modification the method may be applied to other forms with a degree of approximation and reliability dependent upon the amount of curvature in the members comprising the jaws of the fork, and the accuracy with which the position of the critical section is determined.

The Institute of Metals.

No. II.*

THE meeting was resumed in the Hall of the Association of Engineers, Liége, on September 2nd, with Dr W. Rosenhain (Vice-president) in the chair.

CRYSTAL DEFORMATION.

Dr. C. J. Smithells presented a paper of which he was joint author with Mr. H. P. Rooksby and Mr. W. R. Pitkin, on "The Deformation of Tungsten Crystals." It is known that when metals are rolled or drawn the crystal fragments tend to take up a definite orientation with respect to the direction of working. In the present paper it is shown that the same effect is produced during the swaging of tungsten rods. The micro-structure and X-ray diffraction pattern at various stages of the swaging of tungsten rods have been examined with a view to understanding the mechanism by which this "preferred" orientation is attained. Three kinds of material have been used, comprising fine-grained rods having 2250 grains per square millimetre, coarse-grained rods having 659 grains per square millimetre, and rods in which the crystals had an average diameter of 5 mm., and occupied locally the full cross-section of the rod.

Professor F. C. Thompson said in the discussion that the work described in this contribution was of great interest. There was not much to discuss as the account given in the paper was a plain straightforward statement of facts, but the authors were to be congratulated on the beautiful experiment by which they were able to show what happened during the rotation of the crystal fragment.

Dr. D. Hanson also expressed his interest in the points developed in the paper. As far as was known, a single crystal under other forms of deformation did not break up in the manner described. It would add to the value of the contribution if Dr. Smithells could give some information concerning the tensile properties under a condition of random orientation and the effect on density, and supply further details as to what occurred during the swaging process.

Dr. Rosenhain inquired whether the "preferred" orientation might be explained by the assumption that the remainder of the crystal was really non-crystalline in character. There was definite evidence of relative motion of the crystals under slight deformation, and it could be argued with some confidence that there was a return to the amorphous condition. In that case there would be no difficulty in accounting for the rotation which was observed.

SEASON CRACKING.

A paper by Mr. A. Pinkerton and Mr. W. H. Tait on "Season Cracking in Arsenical Copper Tubes" was then presented. In it the authors claim to have shown that, while severely hollow sunk tubes made from arsenic-free, deoxidised copper are not liable to season cracking, tubes made from arsenical copper, according to the British engineering standard specification, are liable to season cracking when made under certain conditions. The temperature at which annealing renders such tubes immune from season cracking has also been determined.

There was no discussion, but Dr. Rosenhain, in thanking the authors for their contribution, said that the phenomena of season cracking had been discussed by the Institute on various occasions from both the theoretical and practical standpoints. The present paper gave some useful information to those engaged in the manufacture of copper tubes.

ACTION OF HYDROGEN ON COPPER.

Dr. Cryil S. Smith read in abstract a paper by himself and Professor Carle R. Hayward on "The Action of Hydrogen on Hot Solid Copper." When copper (wire) containing oxygen is heated in hydrogen maximum brittleness is obtained at intermediate temperatures, and a marked recovery occurs when the action is carried out at temperatures approaching the melting-point. The rate of penetration of hydrogen into cast copper has been determined and certain peculiarities observed. When the oxygen in the copper exceeds 0·07 per cent. the depth of penetration in a given time is greater at about 800 deg. Cent. than at higher temperatures. A theory is advanced to account for this phenomenon. When brittle "gassed" copper is annealed and forged in a non-oxidising atmosphere, the cracks responsible for the brittleness close, and metal of remarkable properties is obtained.

Dr. Rosenhain said that the points discussed were of some importance to manufacturers who had experienced the difficulties to which reference was made. It might be suggested, however, that most of those engaged in the production of copper would consider prevention of the trouble preferable to cure. It would be of interest if the authors could add to the paper some figures giving values for the electrical conductivity of the material with which experiments were made.

GEAR BLANKS BY CENTRIFUGAL CASTING.

Mr. F. W. Rowe introduced for discussion a contribution on "Bronze Worm Gear Blanks Produced by Centrifugal Casting."

Mr. W. M. Corse, who said he had been engaged for some years in the production of the type of casting referred to, regarded the adoption of the centrifugal method as a definite forward step, although it might not be the last word on the manufacture of worm gears. The demand on the manufacturer for gears with greater wear-resisting properties was insistent in the United States and no doubt had been experienced in Great Britain. The call for worm gears to give longer service would continue. Various methods had been adopted to meet the requirements of the service engineer responsible for the operation of trucks and lorries, and had led in American practice to the adoption of the three-sided chill method of casting in which everything except the internal ring of the casting came against the iron surface. That method gave a structure which had proved satisfactory in the United States, and it remained to be seen whether a demand would arise for the worm gears with the higher wear-resisting properties associated with the centrifugal method of casting. At the present time 90 per cent. of the American trucks in service were fitted with the three-sided chill bronze gears, but some of the manufacturers producing the gear blanks by the three-sided chill method had also obtained the equipment necessary for centrifugal casting, which, however, appeared to possess less attraction than it had a year or two ago. He would like to know if Mr. Rowe could give any figures for the wear-resisting properties of gear wheels made by different processes. The Bureau of Standards was conducting a series of experiments on the wear-

* No. I. appeared September 10th.

resisting properties of springs in which the same principle was involved, and it would be interesting to know whether any test, except the long time service test, had been devised which gave accurate figures.

Mr. Rowe, in reply, said he understood that the advantages of the centrifugal casting method were fully appreciated by manufacturers and users in the United States, but that commercial considerations had prevented its general adoption. The three-sided chill casting was a distinct improvement on old practice, and the difference between the three-sided chill casting and the casting produced by the centrifugal method was not so great as that between the one-sided chill casting and that made by the three-sided process. He believed, however, that it ought to be possible by the application of a mass production system of manufacture to put centrifugal casting on a commercial basis. With regard to wear-resisting properties, it was very difficult to obtain accurate figures by experiments. Accelerated wear tests were apt to be very misleading, and it had been necessary to fall back on long-time service tests to obtain comparative results. Those tests with units made by different processes were now being carried out, but it would be a year or two before the actual figures were available.

Age Hardening Effects.

Miss Kathleen Bingham read in abstract a paper on "The Constitution and Age Hardening of some Ternary and Quarternary Alloys of Aluminium Containing Nickel." This investigation is part of a scheme of research on aluminium alloys which has been in progress in the metallurgy department of the National Physical Laboratory, under the direction of Dr. Rosenhain for a considerable time. It consists of two parts, the first dealing with the age hardening of some of the ternary alloys of copper, nickel and aluminium; while the second deals with the constitution and age hardening of similar alloys, with the addition of small percentages of magnesium.

Mr. A. H. Mundey suggested that age hardening might be responsible for the cracking which took place under service conditions. He had in mind the case of a firm of electrical engineers which was mulcted in a sum of £20,000 for material which had to be taken back on account of cracks. It was true that the material was zinc-copper and not aluminium.

Miss M. Gayler referred to several points of detail. She noted that in one curve given the hardness of the specimen dropped after annealing for one hour at 200 deg. A similar effect had been observed in alloys of copper, manganese and silicon, and might perhaps be attributed to the ternary compound rather than to other causes. It did not occur in alloys containing only manganese and silicon.

Dr. Rosenhain, under whose direction the research is being carried out, said that the study of age-hardening effects was originated at the National Physical Laboratory. Referring to the experience quoted by Mr. Mundey, it had yet to be shown that the age hardening of aluminium alloys was associated with the development of stresses which would explain the phenomena of cracking. He would point out, too, that the case of cracking in alloys consisting largely of zinc was very different from cracking in aluminium alloys. The mere fact that cracking occurred in castings months or years after production was due to various causes, and did not necessarily point to internal action. In any case, the age-hardening process was completed within a few weeks. The cracking of the material referred to by Mr. Mundey was probably associated with corrosion, and it was necessary to understand that corrosion in material of the kind in question was often of a very subtle character.

Nickel as Coinage.

In the absence of the author, Mr. W. R. Barclay presented a paper by Captain F. R. Barton on "The Development of the Use of Nickel in Coinage." This paper deals with the historical development of the application of nickel to coinage, and the difficulties encountered and overcome in adapting it to this purpose. In its pure form, as well as a constituent of binary alloys, nickel has been widely adopted during the last half century as a coinage metal. Experience shows that pure nickel coins wear longer in circulation than those made of silver, and that they are equally proof against counterfeiture.

Mr. Barclay said that the author had taken a great deal of trouble to collect the information contained in the paper, and he was an authority on the subject dealt with in his contribution. Many of the objections to the use of nickel in coinage had now been swept away.

Mr. C. E. Barrs quoted some examples of the difficulties which had attended the use of nickel for coinage purposes. There was no doubt that the purity of the metal was of great importance. The magnetic properties of nickel were a more effective check against counterfeiting than was generally understood.

Dr. M. Haas also referred to the difficulty of counterfeiting nickel coinage. From the point of view of purity, nothing superior to nickel was at present manufactured. The small percentage of manganese present had, it was believed, a beneficial effect.

Mr. W. M. Corse said that the author deserved thanks for the trouble taken in collecting the information contained in the paper. It was of interest to note that in Canada use was being made for coinage of an alloy containing 75 per cent. of copper and 25 per cent. of nickel. While the advantage of nickel for coinage was well recognised, it was not going to be a simple matter to get it adopted in America. Silver interests were very strong and would not be easily ousted.

Captain Barclay, in a brief reply on behalf of the author, said it was a common fallacy that a coin should represent the value stamped on it. That idea had now been given up; coinage was only a token of value, and the intrinsic value of the English shilling was about 2d. There seemed to be general agreement that the inclusion of a small percentage of manganese improved the mechanical properties of nickel. With regard to the purity of the material now available, it contained from 99·5 to 99·6 per cent. of nickel.

The other papers on the agenda were taken as read.

Dr. Rosenhain moved and Professor Thomas Turner (Past-president) seconded, votes of thanks to the Association des Ingenieurs sortis de l'Ecole de Liége, and to all those, in addition to the Association, who had co-operated in making the Liége meeting of the Institute a success.

The resolution was carried by acclamation.

Visits to Works.

The afternoon was devoted to visits to the works of the Société Anonyme Fabrique Nationale d'Armes de Guerre at Herstal, and to the shops of the Société Anonyme Union des Usines à Cuivre et Zinc at Liége.

At the first-named works, which were originally laid out for the manufacture only of munitions, the production of sporting rifles and motor cycles and motor cars is now undertaken. A feature of the establishment is the research laboratories, which are divided into a central department which undertakes what may be regarded as fundamental research, and the divisional laboratories where industrial testing and workshop problems are dealt with.

The Société Anonyme Union des Usines à Cuivre et Zinc was founded a century ago. It operates three plants, at Grivegreé, Chênée and Antwerp respectively. The shops visited were those of the first-named establishment, which is the most important, and where tubes, wire, strip and bars are manufactured, the output being about 20,000 tons a year. The shops suffered badly from the general destruction of industrial establishments at the end of the war, and are only now being restored to the old degree of efficiency as regards equipment.

In the evening of September 3rd there was a visit to Chaudfontaine, followed by a dinner and concert, and for September 4th an all-day excursion to Spa by road was arranged, with a picnic luncheon at Coo and a dinner at Spa. The excursion was favoured with fine weather and was much enjoyed.

For the success with which the Liége meeting, which terminated with the visit to Spa, was attended, thanks are due to Monsieur O. Le Personne, secretary-general of the Association des Ingeniéurs sortis de l'Ecole de Liége, and to Monsieur L. Boscheron, the honorary corresponding member of the Council of the Institute for Belgium. Both laboured hard to ensure that all the arrangements should work smoothly and Mr. G. Shaw Scott, the secretary of the Institute, and his assistant gave that consideration to the details of the programme to which members have become accustomed, but appreciate not the less on that account.

SIXTY YEARS AGO.

In our issue of September 14th, 1866, we find a remarkable illustration of the official ineptitude and indifference to the safety of the public which characterised Governmental dealings with trade and industry sixty years ago. We had on previous occasions severely criticised the authorities in Whitehall in this connection, and in particular had attacked the Board of Trade over the manner in which it supervised the inspection of the boilers of passenger steamers. The regulations required that each boiler of every passenger steamer should be provided with a six months' certificate that it was and would be in good working order for that period. The surveyors were officially directed to pass any boiler able to withstand twice the hydraulic pressure of the intended steam pressure. No matter to what extent the boiler bulged or buckled, if it did not actually rupture under the hydraulic test, the owner was practically entitled to demand a certificate stating that his boiler was in safe working order. With this system in operation we felt no surprise that boilers certified as safe occasionally exploded. One such explosion had just occurred on the passenger steamer Talbot, plying between Dublin and Morecambe Bay, and had resulted in the deaths of the engineer, his assistant, and a fireman. On inquiring into the explosion, Mr. Robert Galloway the chief surveyor to the Board, found that the back of the boiler had been forced out as a result of the absence of stays over an area measuring 32in. by 16ft. 4in. Plate stays held by angle irons had been added to this area by an afterthought on the part of the maker, but they had been removed because they formed shelves for the deposit of scale. The second boiler in the ship had also been deprived of its stays, and was found to be on the point of exploding like the first. In a sister ship equipped with the same design of boiler it was discovered that the stays had been hastily replaced on receipt of the news of the disaster. The Board of Trade's culpability in the matter was revealed when it was disclosed that the builder of the boilers at Belfast, was himself the Board of Trade's surveyor at that port, and that after he had made them he officially surveyed them and granted himself and the owner a Board of Trade certificate that they were safe and satisfactory. The touching trust in human nature that expected a man to condemn his own newly made boiler or even afterwards, as it got worn to condemn it for defective construction, reached, we held, the sublime. In fairness to Mr. Galloway we ought to record that in many matters he held opinions opposed to those of his official chief, Captain Robertson, the Board of Trade's Surveyor-General.

THE RIO CLARO WATER PROJECT.

As a result of several months of careful study by Dr. Henrique de Novaes, Chief Engineer of the New Works Commission of the Sao Paulo Water Supply, the Government of the State of Sao Paulo has recently awarded to Braithwaite and Co. (Engineers), Ltd., of Westminster, a contract for the supply of approximately 20,000 tons of pipes in connection with the Rio Claro water supply project. This project, which has been planned in detail by Dr. Henrique de Novaes, aims at augmenting the drinking water supply of the city of Sao Paulo by conveying water a distance of 80 kiloms. from the Rio Claro head waters to a new reservoir to be constructed at Villa Prudente, whence a new and amplified distribution system will supply various portions of the city.

For 44 kiloms. the water will flow by gravity through a reinforced concrete aqueduct designed by the New Works Commission and constructed by three Brazilian engineering firms. It will be necessary to construct approximately 4 kiloms. of tunnel, and where these tunnels are so situated that the water exerts internal pressure upon them, they will be lined with Messrs. Braithwaite's patented tunnel lining. This lining is constructed from Armco iron plates, $\frac{1}{16}$in. in thickness. The plates are hydraulically pressed to form a series of internally flanged segments, which can be bolted together as tunnelling proceeds, so as to form a continuous internal lining, 2·60 m. in diameter.

In those sections of the water main which cross valleys, the water is carried under pressure, which varies according to the depth of the valley. In these sections, which are of a total aggregate length of 32 kiloms., the water will flow through riveted pipes supplied by Messrs. Braithwaite. Of these 32 kiloms. of pipe, 8 kiloms. are 2·50 m. in diameter and $\frac{1}{4}$in. in thickness, and will be under a pressure of 57 lb. per square inch, and 24 kiloms. are 18·0 m. in diameter and $\frac{7}{16}$in. in thickness, and will be under a pressure of 114 lb. per square inch.

In order to ensure resistance to corrosion, it has been decided to utilise plates of Armco ingot iron. The Armco plates will be rolled in England at the works of Guest, Keen and Nettlefolds, Ltd., and will be planed, drilled and scarfed at the Newport (Mon.) works of Braithwaite and Co. (Engineers), Ltd. The plates, thus prepared, will be shipped flat to the port of Santos. From there they will be brought by rail to a pipe factory which will be established by Messrs. Braithwaite at a convenient point on the Sao Paulo Railway. At the pipe factory each plate will be rolled into a complete ring and three or more rings will be hydraulically riveted together to form a tube between 6 m. and 8 m. in length. After all seams have been pneumatically caulked, the tubes will receive a coat of bituminous paint, both internally and externally. The tubes will then be transported by means of special caterpillar trucks and trailers to the site, where they will be jointed, riveted and caulked in position.

Although work on this project commenced only in April of this year, over 80 kiloms. of new road are already in service to facilitate the transport of materials, while other necessary installations, such as warehouses, labour and engineers' quarters, &c., are well in hand.

SEA ENCROACHMENT IN NORTH DEVON.

Westward Ho! in North Devon, is faced with a difficult coast erosion problem. The encroaching sea threatens both the village and its noted golf links, and the authorities and inhabitants are busily engaged in casting about for the best method of countering the menace. At a meeting held on the spot, a scheme was put forward by Mr. Hansford Worth, M. Inst. C.E., of Plymouth. Mr. Worth told those assembled that by building a sea wall, as had been suggested, they would probably make trouble for themselves in the maintenance of the beach outside, for the backwash would be worse than what they got at present. Regarding the suggested use of concrete blocks, he said he thought the idea of breaking the waves up was a good one, but whether concrete blocks were the right thing to use was another matter. His view was that instead of them they should have two lines of short walls at a distance of about twenty or thirty yards from the cliffs. In the front line there should be three or four arrow-shaped walls, and immediately behind the gaps made by these a corresponding number of short walls to break the waves that escaped the first line of breakwaters. He pointed out that the angular formation of the outer walls would tend to divert the backwash from one sea wall to the backwash from another, and so prevent, to a considerable degree, its worst effect. By carrying out such a plan they would find that the pebbles would lodge among and behind these independent walls, while the natural action of the tide in bringing pebbles along the coast to strengthen the ridge would not be affected to any extent. The main idea was to break the wash of the waves which prevented the building up of the beach. The inner walls would not have to be more than 5ft. or 6ft. above the beach anywhere, and the outer walls should be anything above 6ft. A 6ft. wall would have a good effect upon the sea. The gradient on the seaward side of the walls should be one in three, and the walls should be stone-faced. In addition to this plan of protection, Mr. Worth suggested the erection of wooden groynes to help in collecting the pebbles.

Four waterfalls near Arnarfjord, Iceland, are to be utilised by a Danish company for the production of nitric acid by the arc process.

200-TON FLOATING CRANE FOR THE PORT OF LE HAVRE

A 200-Ton Floating Crane.

A 200-TON floating crane was recently completed by the Werf Gusto, Firma A. F. Smulders, of Schiedam, Holland. It was built to the order of the Havre Port Authorities. The crane, which is illustrated on page 308 and herewith, was safely towed from Schiedam to Havre without the jib being unshipped, and it reached its destination towards the end of July. To steady the jib during the journey two lattice legs were employed, as shown on the engraving on this page. They were, of course, removed when the crane had completed its sea voyage.

The crane is designed to hoist a load of 200 tons to a height of 16ft. above the water line, at a radius of 95ft. from the centre of the crane, and a load of 150 tons at a distance of 130ft. There are two main lifting blocks, each designed for 100 tons, which can be coupled together when lifting the maximum 200-ton load. There are also two trolleys, each designed for 30 tons, which, together, will lift 60 tons. They may be operated either coupled or separately, and they can be moved over the whole length of the crane jib. The hoisting speed of the main block is 4·5ft. per minute, and that of the trolleys 30ft. per minute. The crane is designed to slew through a complete circle in about six minutes.

The upper structure of the crane rests on a pivot bearing supported on a tower which projects from the pontoon, and is rigidly fixed both to the deck and to the pontoon bottom. The upper framing is composed of two main parts; the lower platform, containing the winch room and the jib counterweight, and the upper platform, to which the jib is attached by two pin supports. These two platforms are connected together by strong steel bracings. On the aft side of the central tower are the screwed spindles for the derricking motion and the counterweight for balancing the jib, while the bearing rollers around the tower are fixed on the lower platform. In the winch cabin there are grouped the two main 100-ton hoisting winches and the two 30-ton trolley winches, as well as the slewing and derricking gear. All the winches are provided with electric brakes. The movements of the crane are controlled from the crane driver's cabin under the jib, from which an uninterrupted and clear view of all operations can be obtained. The controls are electrical, and are operated by the firm's patented switching gear. Among the advantages which the firm claims for its system of control are the following :—(*a*) There is a definite speed for each position of the control handle ; (*b*) regulation is effected by a small current, so that the energy loss is quite small ; (*c*) the main current is not broken at the switch contacts, so that the latter are not subjected to heavy wear ; and (*e*) efficient safety devices are provided to give immunity from shocks.

Current is supplied from steam-driven generating sets arranged in the pontoon. The generators are driven by triple-expansion condensing engines, working with steam at 147 lb. pressure, generated in boiler plant, also housed on board. The pontoon is subdivided into several watertight compartments, the after deck being specially strengthened to allow loads up to 200 tons to be placed on the deck. There are four steam capstans and one steam windlass fitted on deck for manœuvring purposes. Electric light is supplied to all cabins from a special lighting dynamo. Only three men are, so we gather, required for operating the crane, namely, an engine-driver, a deck hand and the crane attendant. There are cabins for officers and crew, with galleys and lavatory accommodation. Lamp rooms, store rooms, water tanks and coal bunkers are built on the deck or in the pontoon.

Of the foreign trade of China during last year 39 per cent. was carried by vessels flying the Japanese flag, while nearly 26 per cent. went in British ships. No other nationality exceeded the American quota of 9·27 per cent. of the whole.

Steam Pipes for Extra High Pressure and Temperature.*

By J. A. AITON.

THE first matter to decide is what is meant by extra high pressure and temperature, and for the purpose of this paper these have been fixed at steam at 440 lb. pressure and superheated at 750 deg., as these may be considered to be the limits of normal working at present.

Experience of these conditions has so far been chiefly in land practice in electric power stations, some of the difficulties to be met with in laying out piping on land are either much smaller or are not met with in marine work at all, but, on the other hand, due to the confined space on board ship, others are much exaggerated ; for instance, on board ship the run of the piping cannot be varied to any great extent, although here also simplicity should ever be aimed at, but for the same reason the method of allowing for the movement of pipes due to expansion by means of wide bends in the run of the pipes cannot be adopted. For this reason sliding expansion joints or ball joints have been largely used and have been fairly satisfactory with lower pressure saturated steam, but with superheated steam they are not satisfactory and have practically disappeared from land practice. We are thus thrown back on bends, but these must be of short radius and consequently so very stiff that excessive thrust comes upon the fixed points if any serious movement has to be allowed for, and great stresses are set up in the joint, moreover, bends made to short radius show quite appreciable thinning of the wall on the outside of the bend. Undoubtedly the most serious difficulty which will be found in fitting pipes on board ship to carry high pressure steam is this one of dealing with the movements due to expansion, and if the two methods of meeting the difficulty, mentioned above, were the only ones the position would appear to be very difficult indeed, but fortunately another method has been devised whereby bends are made which are much more flexible than those made from plain tube.

This method is to form a series of corrugations on the tube, these in themselves strengthen the tube, especially as the process of manufacture thickens the wall of the tube ; the corrugated pipe is then formed into a bend in the usual way and there can be no thinning of the wall in bending, as all that happens is that the corrugations are somewhat opened out on the outside of the bend and are closed up on the inside.

These corrugated pipes can be bent to a much smaller radius than plain pipe, in extreme cases they can be bent to the same radius as an elbow ; in all cases, to stand corrugating, the tubes must be of a good soft quality of steel and must be well made, free from variations of thickness ; they are usually solid drawn tubes, hot finish, 24 tons to 28 tons tensile, 25 per cent. elongation in 8in.

Bends made from corrugated tube are five times as flexible as similar bends made from plain tube, that is to say, that if the same thrust is applied to both bends the corrugated one will move five times as far as the plain one, or if the same movement is required only one-fifth of the thrust required to move the plain bend need be applied to the corrugated one, or again, if the same amount of movement is required and the same amount of thrust can be applied to both bends then the corrugated bend can be made to a much smaller radius, and it is this last quality which will be found so useful by the marine engineer.

Comparison of the lyre type of expansion bend is interesting, such a bend from plain tube is 138in. high from the centre of the main to the centre of the pipe at the crown of the bend, and allows for a movement of 2¼in. out or in ; a bend made from corrugated pipe of the same bore can be made 55in. high and gives 2¼in. out or in, and a similar bend 72in. high gives 3¾in. out or in, or 50 per cent. more than the much larger plain bend.

* Institute of Marine Engineers, Tuesday, September 14th. Abridged.

For expansion purposes straight corrugated pipes are not often used for end-on movement between the flanges, because the corrugations are not high, and to obtain a very small end movement, ·01in. per corrugation, a pressure of many tons is required, but corrugated pipes, both bends and straights, are used with great success to overcome vibration or movements due to the working of a ship.

This question of corrosion taking place owing to water collecting in the corrugations is often raised ; practice has not shown that there is any more corrosion in a corrugated pipe than in a plain pipe ; it may be that the reason why corrosion does not take place is that the water does not lie long enough to start the action, it lies in very small separated quantities exposing a very large surface to steam and to hot metal, and is consequently very soon evaporated off, but undoubtedly this dividing up of the water is a great safeguard against water hammer.

The friction loss in steam passing round a corrugated bend is double that for a plain bend. This in itself is not a serious matter, but when it is remembered that the number of corrugated bends is much fewer to do the same amount of work, the advantage in this also is usually on the side of corrugated bends.

Injudicious anchoring causes expansion stresses by endeavouring to force the pipe into a position where it would not naturally go. The ideal plan is to have no anchoring at all, as it is frequently only necessary to guide the pipe in the direction in which expansion should take place, but this ideal cannot always be attained, in which case anchors must be fitted, but considerable experience is required to place them in the right position.

The working of modern steam pipe lines is a new problem, and must be treated in a new way, for that which can be done with comparative impunity on lower temperature work will cause very serious trouble if attempted with high temperature work. For instance, to bring a boiler on to a main carrying superheated steam ought to be a very slow process if trouble with pipes is to be avoided.

Referring to questions of the design and manufacture of the pipes themselves, undoubtedly the weakest part of the pipe line is the joint, and as every joint is a potential cause of trouble, the obvious aim should be to reduce the number of joints to a bare minimum by making each pipe as long as possible. As castings, even of steel, are no longer used in first-class pipework, and as modern methods allow branches to be fixed to any part of the pipe, it is possible to use straight pipes up to 35ft. or even more, and 30ft. is quite a common length. Obviously, it is not always possible to take advantage of the longest lengths of tube, especially with bends, owing to the lack of facilities for transport, and, of course, this applies to marine work, but even there joints could sometimes be eliminated by taking fullest advantage of modern practice.

The entire elimination of joints by butt welding pipes end-on in position is very attractive, and there is an instance at work in this country. This main is 6in. bore, one straight length is 260ft. long, steam pressure is 350 lb., and the temperature is 750 deg. Fah., there are two anchors 200ft. apart, and the expansion is taken up by one corrugated lyre type expansion bend 100in. high. There is only one pair of flanges on the job, and these are at the crown of the expansion bend. Care is taken to keep the pipe true to alignment by means of roller guides which prevent cross stresses coming upon the butt welded joints, and where, in spite of this precaution, there is any possibility of cross stresses coming upon the joint it is reinforced by having collars welded over the butt weld. It is early yet to say that this method of joining pipes will supersede flanges, but in special circumstances it will be found very useful.

A joint which aims at a similar result is that known as the "Sargol" joint, used in America, in which the end of the pipe is rolled over and loose flanges are used. All mechanical stresses are taken by the flanges, and a steam tight joint is made by welding round the edge of the rolled-up portion of the pipe. This system has its drawbacks, which have so far prevented its adoption in this country, where fixed flanges are almost universal for high pressure work.

In the use of flanges for piping there are two main questions to consider, namely, how to attach the flange to the pipe, and how to make the joint between the flanges. Regarding the first, there are nowadays only two methods of fastening flanges to pipes, namely, by riveting and by welding, except in the case of small pipes, which nearly always have flanges fixed by screwing. It seems on the face of it to be wrong that holes should be made in a pipe to be afterwards closed by rivets. A satisfactory job, however can be made in this way, but sudden variations in temperature may start a leak even after the pipe has been in use for a long time, and if a rivet does leak under high pressure high temperature steam it is almost impossible to make it tight. Frequently the presence of rivet heads inside the pipe, coming very close together, seriously reduces the area of passage.

With high velocity steam this either means a continuous loss due to a greater pressure drop, or a larger sized pipe to pass the same weight of steam, with resultant loss in working due to increased radiation surface and higher capital outlay.

Riveting is highly skilled work, for under existing conditions it must be perfect from the start. In the days of low-pressure saturated steam, free use of caulking would make almost any rivet tight, and would cover up bad work, this is far from being the case with high-pressure conditions.

Flanges properly welded to pipes are subject to none of these disadvantages, but unfortunately there are many methods of welding flanges, and they are not all satisfactory, and for this reason welding of flanges is still regarded by some with disfavour, but experience has proved that welded flanges can be entirely satisfactory for highest pressure and temperature work.

The only satisfactory method of fastening flanges to pipes is by welding them on by means of the carbon arc process. Unless the flanges are exceptionally thick, a continuous weld should be formed right through the flange from back to front, and, in addition, a good fillet should be worked up at the back of the flanges. As this is a process of building up the weld bit by bit, it takes considerable time, and demands skill on the part of the operator, but it should be pointed out that he is able to control the work and the temperature quite easily at every instant, provided

he is given the right current, the right type of machine, and the right materials to work with.

In the early days of welding it was very difficult to prevent testers caulking up a pin hole leak in a weld, for a soft weld lends itself to this treatment, but highly superheated steam soon finds out the weak places, and trouble results. To attempt to caulk a leaky weld is very short-sighted policy, although it seems to be such an easy way out of the difficulty. An argument frequently used against welding flanges by any process is, that so much depends upon the human element, but is this more so with welding than with most engineering work, or than with riveting ?

Having fastened the flange to the pipe, the next important question is how to make the joint. Many methods are employed to accomplish this, but before considering them some essentials of a good joint, whatever the method adopted, may be enumerated. The flanges must be heavy to reduce to a minimum the probability of springing, the joint must be made on a raised face inside the bolt holes, and a ground face is very desirable, though not essential. There is no mystery about the making of high-pressure joints. By care, experience, and the use of good materials, joints made by the same methods as have been used for many years are giving satisfactory service to-day, that is to say, with an ordinary corrugated metal ring and a wash of thin cement.

Many such joints, subjected to the working conditions of large power stations have been in use for years, and have never been touched since they were made, but it must be added that in the original lay-out of the piping, expansion stresses must be reduced to a minimum and every care taken to prevent water collecting in the pipes. Expansion stresses and water are the two great enemies of pipe joints, and water is by far the worse.

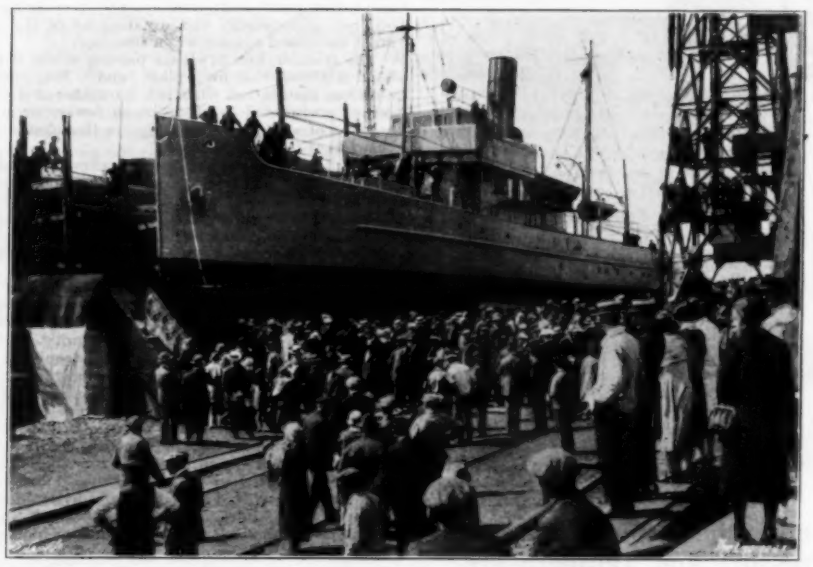
The effect of water on joints, subjected alternately to high temperature steam and water, is to set up a chemical action with the paste used for the joints, and so to produce a slight acidity in the water. This acidulated water seems to set up electrolytic action, which quickly destroys the joints. It has not been found possible to make a paste which will not be affected by the action of water and at the same time be satisfactory in all other respects.

No good joint can be made with the wrong type of bolt, bolts made from steel of from 30 tons to 35 tons tensile strength have given most satisfaction, and have been adopted as a standard. Bolts made from high tensile steel have shown a liability to brittleness after being subjected to variations of temperature.

Where branches have to be taken off pipes this should be done by means of welded-on stools, and experience has shown that the oxy-acetylene process is the most suitable for this work. At one time branches were welded on by the carbon-arc process, but, though to all appearance the weld was quite normal, it sometimes broke down under test, and as there was a possibility that one such branch might pass the test and yet break down in working, the risk was considered too great, so this process was given up. Oxy-acetylene welding is more expensive, but it has given no sign of failure in working. In branch welding there are only two thin pieces of metal to be dealt with. Therefore, the period during which the full temperature of the carbon arc can be kept on the metal with safety is very short. This is possibly the root of the trouble, and if so, it is inherent in the process. The branch piece is not taken through the pipe, because it is necessary to get access to the joint from the inside, both with the blow pipe and with the hammer, and as this can often only be done through the branch the joint must be inside the branch. Cast steel tees must be ruled out of this class of pipe work, owing to the great increase in the number of joints, and riveted stools, owing to the fact that they must usually be riveted by hand, are not often satisfactory, and, as they can only be fixed near the end of the pipe, they cause a lot of otherwise unnecessary joints in the main. It is advisable to have as few joints as possible. With simple design and large units, it should be possible to do away with branches, and to bring the pipes into vessels which serve as collectors and distributors as well as drainage points. Collector vessels should be placed with the axis vertical, for in this position it is easier to arrange the branches and the drainage, and vessels so placed are not subject to hogging stresses which are prevalent in vessels placed horizontally when water accumulates in them.

A New Minesweeper for Latvia.

On Wednesday, August 11th, there was launched from the yard of La Société des Chantiers et Ateliers Augustin-Normand at Le Havre, the new minesweeping vessel Imanta, which has been built by the firm to the order of the Latvian Government. It will be recalled that the Government of Latvia recently ordered in France four naval vessels comprising two minesweepers and two submarines. The firm of Augustin-Normand is constructing the two submarines and one of the minesweepers. Our illustration shows the Imanta in practically a completed state just before she left the stocks. She has the following principal dimensions :—Length overall, 48·78 m. ; beam 6·45 m. ; and draught, 1·50 m., with a displacement of about 255 metric tons. The engines and boilers were also constructed by the builders, and the vessel is designed for a speed of 14 knots.



THE LAUNCH OF THE LATVIAN MINESWEEPER IMANTA

The first of the two Latvian submarines to be launched at the Augustin-Normand yard was the Ronis, a vessel of 390 tons surface displacement, that event taking place early in July last. Work on the second sister submarine, the Spidola, is well advanced, and the launch will take place at no distant date.

The Smoke Abatement Exhibition.

As suggested in the Seven-Day Journal of our issue of September 10th, the most interesting part of the Universal Smoke Abatement Exhibition in the Bingley Hall, Birmingham, which closes to-morrow, is what has been called the "Model Boiler House." The remainder of the Exhibition is devoted principally to domestic appliances, such as gas stoves, vacuum cleaners, electric heaters and so forth ; but with these we are not here greatly concerned. Dotted about among these exhibits there are, however, several of technical interest, and we refer to them concurrently with the plant in the boiler house, although they must be looked for elsewhere in the Hall.

The model boiler house, it should be pointed out, is not a small-scale replica of a complete steam-raising plant but is rather a collection of typical appliances that would not necessarily be grouped together as shown.

Boilers, for instance, are represented by parts of a Lancashire and a water-tube boiler, both by John Thompson, Ltd., of Wolverhampton. The Lancashire boiler is of the maker's dished end type, and is 9ft. 3in. in diameter—the largest size which can be conveyed by rail—with corrugated flues 3ft. 8in. in diameter. One of the furnaces is fitted up with a Meldrum Koker type stoker, and the other for hand firing with forced draught. At the back of the boiler there is a sectional superheater by J. Gordon and Co. The water-tube boiler is of the straight tube type, and is intended for a working pressure of 300 lb. per square inch. It has an integral superheater. The combustion chamber of this boiler is roofed with a suspended arch, by Liptach Furnace Arches, Ltd., of 38, Victoria-street, S.W. 1, and is supplied with powdered fuel by an Atritor pulveriser made by Alfred Herbert, Ltd., Coventry. At the Exhibition, for obvious reasons, coal is not passed through the pulveriser, but the apparatus is shown running.

Another system of firing is the chain-grate stoker by Ed. Bennis, of Little Hulton, which is shown fitted up with a Lea coal meter. There is also a section of a Lancashire boiler equipped with Bennis sprinkler stokers, and it is noteworthy in view of the ostensible object of the Exhibition, that Messrs. Bennis' representative told us that they had recently been complimented by several municipal officials on the success of their efforts to reduce the smoke emitted from the chimneys of local works. A chain-grate stoker is also exhibited by Babcock and Wilcox, and is fitted with a new totally enclosed four-speed electric drive, worked by a 1 horse-power electric motor running at 1000 revolutions per minute. The most interesting exhibit on this stand is, however, a pressed steel tank, 23in. long by 14in. wide by 16in. deep, made of ¼in. plate. It was, we understand, made by the use of four sets of pressing dies, and we were assured that if it were drilled at any part the plate would be found to be of full thickness.

Two other systems of boiler firing, exhibited in other parts of the Hall, are the throwing stoker of the Crosthwaite Engineering Company, Leeds, and the Turbine Furnaces, 238B, Gray's Inn-road, W.C. 1, with which our readers are familiar. The most novel system of firing shown at the Exhibition is, however, that of Wollaston Gas Producers, with offices in Bank of England Chambers, Tib-lane, Manchester. It takes the form of a gas producer burning coke, on the top of which is directly mounted a standard Cochran vertical boiler, capable of evaporating 650 lb. of water per hour at a pressure of 100 lb. per square inch, and was described in THE ENGINEER, February 5th, 1926. This boiler is shown at work, and there are connections at the bottom of the smoke stack, with two recording instruments. These recorders show the remarkably high average content of CO_2 in the flue gases of 17 per cent. while there is no CO. A fan is used to supply air to the gas producer, but only requires 0·8 horse-power in the case of the plant exhibited. The makers claim a thermal efficiency for the combination of 78·8 per cent. The producer can, of course, be fitted to other forms of boiler, but it is pre-eminently suited to the vertical type. Several other schemes for burning fuel under boilers are exhibited, but we will content ourselves with reference to the gas-fired boiler of the Spencer-Bonecourt Company, Parliament Mansions, S.W. 1, with which we have dealt in the past, and the Lopulco system of burning powdered coal, which is shown by the International Combustion Engineering Corporation, of Africa House, Kingsway. On the stand of this company there are some of the most realistic representations of the working conditions in a furnace using powdered coal which we have ever seen, produced by a scheme of illuminating a screen of opalescent glass, and some specimens of water-cooled furnace walls. The principle of the latter is a series of water tubes arranged at short distances all round the combustion chamber, with the intervening spaces filled in with fins welded on to the sides of the tubes. These fins are of such a thickness and width that the heat which they absorb from the furnace is conducted away to the water in the tube sufficiently rapidly to prevent the fins being burned away.

Going back to the model boiler house, there is a little 1¾in. by 2¼in. by 3in. Weir feed pump at work, supplied with steam from the Cochran boiler already mentioned, and so far as we could follow out the piping arrangement, circulating water through a Lea recording water meter. Incidentally, the steam for the pump is passed through a reducing valve supplied by British Area Regulators, of Windsor House, S.W. 1, while the model steam range, from which it draws, is by the Bromford Tube Company.

For the purpose of supplying, in imagination, the model boiler house with feed water, there is a full-sized softening plant by the Paterson Engineering Company, of Windsor House, Kingsway, which works on the lime-soda principle, and is capable of dealing with 1500 gallons of water per hour. The same company is also showing a "Basex" base exchange softening plant and a pressure filter. In the way of measuring and testing instruments for boiler house service there is a great variety, which includes the Kent boiler load indicator, a feed meter by the same company, the Mono combustion recorder—an apparatus for showing CO_2 and CO on one chart—meters and gauges by Bailey and Avery weighing apparatus for coal and water.

The growing vogue for powdered fuel has, naturally, brought to the fore the problem of eliminating from flue gases the dust or ashes which must otherwise be distributed over the surroundings of a boiler house, and this phase of the campaign towards the purification of our atmosphere is demonstrated by Davidson and Co., of Belfast, whose dust-extracting induced draught system we have already described ; while the James Keith and Blackman Company, Farringdon-avenue, have a model of an induced draught fan, for which the patent is not yet completed, that has much promise in the way of the reduction of the flue dust nuisance.

Among those exhibits which may be described most precisely as being connected with smoke abatement, one of the most prominent is that of the Woodall-Duckham Vertical Retort and Oven Construction Company, of London, which comprises some excellent working models of continuous, inclined and intermittent ovens for coking coal, and a new development in the form of a centrifuge, which, working continuously, will reduce the water content of washed coal down to at least 5 per cent. On this stand there are also some most interesting samples of coke, set in plaster of Paris and highly polished, which illustrate the progress of coking and show up very plainly the effects of the inclusion of ash in the coal.

Some idea of the miscellaneous exhibits in the Hall may be gathered from the fact that they include chains by the Aston Chain and Hook Company, B.T.H. electrical appliances, Magnet electrical cookers, belt fasteners, and the usual collection of persistent exhibitors.

There is, however, one other exhibit which we would like to mention, as it is an example of effort on the part of a purely mechanical engineering firm to reduce to a scientifically efficient and commercial stage a phase of heating which has in the past been mostly guided by rule of thumb. This exhibit is that of Wm. Grice and Sons, of Birmingham, and comprises several air heaters, the general principles of which were described in THE ENGINEER of July 2nd, 1926. Since that time, however, some improvements have been made in the design of the heater, and its capacity for warming, rather than heating have been considerably improved.

Among the other exhibitors who need no recommendation to our readers, there are Bell's United Asbestos Company, the Kennicott Water Softener Company, and the Mitchell Conveyor and Transporter Company, of Holborn.

A SPECIAL device to guide ships into the harbour, however thick the fog, has been installed at Calais. The apparatus consists of a siren, the vibrations of which are of such high frequence as to be imperceptible to the human ear. Immediately below the siren is a wireless aerial connected with an apparatus below the water, which projects the waves of sound outwards, over a very small arc of a circle. Every ship carrying a suitable receiver can pick up the sounds and make straight for port.

South African Engineering Notes.

Rubber from Euphorbia.

A factory for treating euphorbia has been established at Durban, and is about to start work, while another is being erected at East London. Up to quite recently no interest had been taken in this tree, which has long cumbered the waste places of South Africa. It was not classed as dangerous to man or beast, and its wood was not worth collecting for fire or other purposes. Now, however, farmers and speculators are taking absorbing interest in the euphorbia, for its gum, resin, or sap is considered to be of commercial value, and concessions are being acquired over all the euphorbia-ridden lands in the Bathurst district and along the coast to Natal and Zululand, even to Portuguese East. The euphorbia tree is said to exude a viscid white juice or latex, which is very copious. About 7½ per cent. of this latex, so it is reported, can be worked up to compare very favourably with certain kinds of rubber. It contains, so it is said, a constituent which is lacking in natural rubber, and is added to the latter when manufactured into the rubber of commerce. It is stated, too, that a ton of latex can be extracted from sixteen euphorbia trees in a year, by tapping once a month. In order to draw the juice, a special appliance known as a "puller," which keeps the juice flowing, is employed. After the first three months the puller is dispensed with, for a tree becomes more and more amenable in its yield.

Natal Electrification.

From a traffic point of view, and no doubt also from that of revenue-earning as well, the achievements on the portion of the Natal Main Line between Glencoe and Maritzburg, which has been electrified, are most impressive. Trains of 1500 tons are being hauled daily up Wessels Nek bank going eastwards, by three-unit electrics, in twelve minutes, whereas the big steam locomotives took 35 minutes to struggle up with 600 tons. The electric units are averaging 7000 miles per month, as against the steam units' 2500 miles, and some of these units have already done seventy and eighty thousand miles without an overhaul. Recently note was taken of a truck of coal, part of a train leaving a point just south of Glencoe at ten o'clock one morning. Durban was requested to report the day and hour of its unloading into ship at the Bluff. It was unloaded next morning at 8.30. Under steam conditions three or four days were taken to achieve the same result. Trains of 1500 tons, occupying most of the length of the sidings, are moving at 20 miles an hour before half their length has left the siding, and they ascend the banks at 22 miles an hour, where steam stuttered along at eight or six, with less than half the weight.

Motor Vehicles in South Africa.

At the end of 1925 there were 63,030 motor cars running in South Africa. There were also 4258 trucks and 23,293 motor cycles. Of the motor cars the Cape had 28,568; Natal, 8300; Transvaal, 18,980; and the Orange Free State, 7182. The number of motor trucks in each Province was:—Cape, 2272; Natal, 954; Transvaal, 937; and the Orange Free State, 95. The Transvaal led the way in motor cycles, having 12,126; the Cape, 6104; Natal, 4061; and the Orange Free State, 1002. During 1925 the United Kingdom exported to South Africa 1613 motor cars, valued at £358,245, against 722, valued at £195,795, in 1924; the United States of America sent to the Union 10,560 motor cars, valued at £2,020,565, as compared with 7181, valued at £1,480,987, in 1924; Canada sent 5420 cars, valued at £603,161, as against 5078 cars, valued at £691,266, in 1924. Value of motor trucks from England, £24,080; from the United States of America, £73,520. In motor cycles the United Kingdom has regained its supremacy, sending in 1925 4498 motor cycles, valued at £193,537, against 2370, valued at £119,674, in 1924; the United States of America was next with 1498, valued at £68,553, as compared with 869, valued at £48,185, in 1924. The value of the pedal bicycles from the United Kingdom was £216,290, against £156,022 in 1924; the United States of America only sent cycles to the value of £1234, against £2845 in 1924. Germany sent cycles to the value of £22,270, as compared with £15,312 in 1924.

Union Miniere Flotation Works.

The Union Minière's—Belgian Congo Copper Works—pilot flotation plant—Minerals Separation patent—having given satisfaction, a large flotation plant is being built at Panda, and it is expected that it will start working next year. This flotation plant is the complement of the reverberatory furnaces plant, and of the concentrator. In the pilot plant palm oil is used as the modifying agent.

Durban's Electricity Bill.

The consumption of electricity in the Municipality of Durban (Natal) has increased in the past three years 33⅓ per cent., from 36,000,000 units in 1923 to over 48,000,000 units in 1925. This rise has been coincident with great activity in the building industry. In 1923 846 buildings were erected at a cost of £926,727; in 1924 there were 799 buildings erected, valued at £957,024; and in 1925 the value of 901 new buildings erected was £1,209,662.

Witbank Colliery Fire.

The dangerous conditions created by the fire in the Witbank Colliery—Rhodesia—in July decided those in charge to close off the area in which the fire was burning. Bore-holes were sunk from the surface to the fire zone, down which water and sand were lowered, and this procedure, coupled with the closing of the affected area, should, it is believed, extinguish the fire in time. The opening up of the northern section, which is already in hand, will be pushed on as rapidly as possible, and it is expected that in from six to nine months it will be possible to produce sufficient tonnage from this section to make up the shortage caused by the fire. The work of equipping and opening up the southern section will be accelerated. In the meantime extra shifts are being worked at Uitspan, and an increased tonnage is being obtained from that section.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Conditions.

In the Midlands the industrial position shows a little improvement. Some processes of manufacture which had been rendered almost impossible through lack of assorted fuels, are now being facilitated once more. With the additional labour available collieries are beginning to screen the coal again before sending it from the pit head. This is a great boon to many of the metal-working branches in Birmingham. There is no movement of note in the iron and steel situation. The total output from this district is insignificant in comparison with the requirements. Dependent industries are having recourse more and more to supplies from outside. However, nothing is now bought except for the most urgent requirements. Buyers prefer to wait until contracts can be made on what they consider to be a reasonable business basis. The weekly iron market in Birmingham to-day was largely attended, but very little business was transacted. There was little change in the price position.

Steel.

Most Midland steel works have good order books and are not anxious for new business. Some plants will be occupied for three months in fulfilling their present engagements. But there are exceptions, and occasionally a manufacturer is found who is willing to take orders for constructional steel on the pre-strike basis of £7 7s. 6d. When ample supplies of fuel are obtainable, the steel works will be able to produce on a scale so large that record production could easily be reached. It is argued that any possible abnormal demand will be quickly overtaken, and inclinations to price inflation will find adequate restraint. Production in this district is confined to steel bars, sections, and to strip rolled from imported material. Structural steel plates rolled in the North can be bought for quick delivery at £9 2s. 6d., but the quantity available is limited. Mills are booking orders for execution after the deadlock at £8 2s. 6d. For small bars £8 10s. is asked, delivery dates being provisional. Bedstead angles fetch £8 12s. 6d. Bright drawn steel is difficult to get. Stringency in the continental market has been sharply accentuated. There are scarcely any offers of semis, except from Germany. Quotations have advanced sharply. For 2in. billets £6 is quoted; for sheet bars £6 5s.; and for finished bars, £6 10s. The effect is to deter consumers from commitments which they consider speculative. As foreign mills cannot deliver under twelve to sixteen weeks consumers are disposed more than ever to rely on the deliveries which have been already contracted for.

Pig Iron.

There is little, if any, change in the raw iron market on the week. Supplies of Cleveland iron are perhaps a little more difficult to obtain, but consumers manage to satisfy their small requirements from one source or another. Values remain as a week ago. Durham No. 1 foundry is quoted £5 11s. 3d., delivered Birmingham, and No. 3 £5 6s. 3d. Some further stiffening of the Middlesbrough market has been reported this week; but little change was apparent on 'Change in Birmingham to-day—Thursday. The price level for Cleveland iron does not differ much from that which applies to Durham makes. East Coast hematite has appreciated slightly. Current output is not equal to the demand, and stocks are being depleted. For mixed numbers £5 is required, delivered Birmingham.

Wrought Iron.

South Staffordshire wrought iron plants remain at a standstill, suitable coal at the right price not being available. Users of Crown bars are buying from Lancashire, paying £12 10s. and upwards. Orders are kept down to the lowest limit, as consumers consider the price far too high. Darlaston nut and bolt works are using Belgian bars almost exclusively, and many complaints are heard of delay in deliveries. Shippers want slightly higher rates for new business.

Galvanised Sheets.

Manufacturers of sheets who have sold most of their prospective output over the next month or so, ask £16 10s. to £16 15s., according to urgency of delivery for 24-gauge galvanised corrugated sheets. Business has been taken at less than this, however, by firms whose resources are disengaged.

Fuel.

The large and daily increasing production of coal from the Warwickshire and Cannock pits has brought ample supplies of coal in the market for industrial and domestic purposes, but the price obstacle is sufficient to keep the Staffordshire ironworks idle. There is no possibility of increasing the price sufficiently to cover the extra cost. Many engineering works, however, are utilising it, and so keeping the wheels of industry revolving.

Another Ironworks Closed Down.

It is regretable that yet another large ironworks has been forced to close down, owing to the shortage of coal due to the continuance of the miners' strike. This week the Alfreton Ironworks, Derbyshire, belonging to the Stanton Ironworks Company, Ltd., has shut down for an indefinite period. It is to be hoped the stoppage will be of short duration, and that the company will in the near future be able to satisfy all its requirements in the matter of suitable fuel.

Effects of the Strike.

The effects of the prolonged strike on the iron and steel industries of the country are clearly shown by the latest returns of the National Federation of Iron and Steel Manufacturers. There were only six furnaces in blast in the kingdom at the end of August, compared with eight at the end of July and 147 for April—before the coal stoppage. The production of pig iron for the month was 4300 tons below the previous month, being 13,600 tons, against 17,900, and comparing with 444,500 tons for August last year. The production of steel ingots and castings, one is pleased to note, showed a little recovery, the output being 52,100 tons against 32,100 for the previous month and 477,100 tons a year ago.

Engineering.

Many engineering departments in this district which went along unimpeded during the earlier stages of the struggle in the coalfields, are now getting into difficulties, for the manufactured products which are their raw materials are extremely difficult to obtain. All the stocks are used up, and present production is so small, when compared with the demand, as to be almost negligible. The constructional engineering branches have been thrown out of action. Emergency supplies which have come on the market have been very welcome in relieving the dearth, and importation has been largely resorted to. But as reserves are used up, it is seen how very far short of the requirements the means of replenishment fall. Electrical engineering and the various departments of mechanical engineering are not as badly hit as are the constructional concerns. Machine tool makers are in many cases busy. Here and there night shifts are being worked. Machinists who are not running their plants at high pressure have, with few exceptions, enough orders to keep them occupied.

More Miners at Work.

The situation in the Midland coalfield continues to improve, and at nearly every pit the number of miners at work steadily grows. At the time of writing the total in the Warwickshire coalfield stands at 9929, Cannock Chase, 9363, and Nottinghamshire and Derbyshire 27,223. Practically all the pits in the South Staffordshire area are now working double shifts. Over 80 per cent. of the men are back. A very appreciable tonnage of coal is being raised daily, and a large proportion of it is finding its way to Midland works. It is hoped additional plant will be put into operation as fuel becomes more easily obtainable, for many of the works have good order books.

Derbyshire Mineowners' Offer.

Mineowners in the South Derbyshire coalfield this week, in pursuance of the policy of district settlements, circulated among the miners the following terms on which they may return to work up to June 30th, 1927:—A percentage of 46·67 on the 1911 base rates is guaranteed to each worker on the basis of an eight-hour day. The daily rates of wages to lower-paid men will remain at the same figure as in April last. The offer means that all day-wage men will receive the same daily rate of wage as before the stoppage, on condition that they work one hour longer per day. The additional allowance on piece rates granted because the hours were reduced from eight to seven in July, 1919, is withdrawn. The extra hour will enable pieceworkers to maintain the same daily rate of wage as before the stoppage. The owners are willing to discuss terms for a permanent settlement. The Clay Cross Company, Ltd., which owns a large number of pits in mid-Derbyshire, has also made a new offer to the miners. The terms in this instance are based on a seven and a-half hour day, and the minimum percentages are to be the same as before the stoppage. In April next wages will be based on the results of working in the months of December, January and February, and afterwards on the usual three-monthly ascertainments.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery.

The effect of the Russian contracts on the Lancashire textile machinery industry is reflected in the Board of Trade returns for August. Shipments to Russia during the past month were valued at £164,417, against £91,000 in July, only £21,000 in August, 1925, and about the same figure in the corresponding month of 1924. The British East Indies were the next best customer, taking textile machinery to the value of £164,898, followed by Japan, £75,361; South America £69 594; France, £62,753; the Netherlands, £49,297; and Australia, £37,387; "other European countries," excluding Germany, being responsible for £132,556. Shipments to Germany during August were valued at £17,663. The overseas demand for textile machinery is, of course, the mainstay of the textile machinery industry, for business on domestic account has been relatively small for a long time, as a result of the unsatisfactory position of the cotton industry in this country. The Japanese market, as the above figure shows, is an important one, and an expansion in that direction is expected as a result of recent legislation in that country by which night work in the cotton mills will be abolished in three years' time. This is expected to lead to a mill building boom and a consequent growth in the demand for equipment. Important Japanese contracts for textile machinery have recently been booked by Platt Brothers, of Oldham. Other firms are still busy completing orders in hand, and additions to these are expected before very long.

Engineers Keep "Open House."

In connection with Manchester's Civic Week to be held from October 2nd to 9th, reference to which has already been made in this column, quite a number of firms, mainly concerned with the engineering and allied industries, have decided to throw open their works for inspection by the interested public on certain days. The firms in question include Henry Simon, Ltd., Cheadle Heath,

near Stockport; the Lancashire Optical Manufacturing Company, Ltd. Exchange-street, Cheetham, Manchester; Crossley Motors, Ltd., Gorton, Manchester; Trafford Park Cold Storage, Ltd., Trafford Park, Manchester; Redpath Brown and Co., Ltd., Trafford Park, the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park; the Carborundum Company, Ltd., Trafford Park; Superheaters Company, Ltd., Trafford Park; Edward Wood and Co., Trafford Park; Richard Johnson, Clapham and Morris, Ltd., Trafford Park; the Ford Motor Company (England), Ltd., Trafford Park; the British Oxygen Company, Ltd., Trafford Park; Butterworth Brothers, Ltd., Newton Heath Glass Works, Manchester; and Mirrlees, Bickerton and Day, Ltd., Hazel-grove, Stockport.

Non-ferrous Metals.

Tin continues to be the chief centre of interest in the non-ferrous metals markets. The metal is now well over the £300 mark, and is still "going strong." Belief in its statistical strength continues, and it is anticipated that values will go higher before any serious relâpse takes place. Before the latter occurs a substantial increase in buying for United States consuming industries is expected. Copper keeps steady without, however, any movement of note. Heavy sales of this metal have been made during the last week or two, and stocks in this country have been much reduced in consequence, official estimates of the position at September 1st placing stocks at about 42,700 tons, compared with 48,700 tons at the beginning of the previous month. Domestic buying is naturally seriously affected by the coal stoppage, but American and European consumption keeps steady. There has been more talk during the past few days regarding the United States Copper Export Association; this time we are told its operations are to commence at the beginning of October. Lead has displayed some easiness, although the loss has not been important, the effect of the coal stoppage in this instance having had its influence on the market. Spelter keeps fairly steady, without any special features.

Iron.

Last week I hinted that the Derbyshire iron makers, who for about a month have been quoting for delivery after the coal stoppage is ended, might before long decide to withdraw their forward quotation of 80s. per ton on rails at the furnaces. They are doing this sooner than was expected, for one of the largest Derbyshire makers selling on this market stated this week that it had withdrawn, the reason being the pronounced uncertainty regarding the future price position. During the past few weeks quite a number of orders for pig iron have been booked on the above basis, but invariably they were for relatively small parcels, users generally being too nervous to operate freely. This nervousness has, apparently, now spread to the Derbyshire makers. What they are chiefly concerned about is the price of blast-furnace coke, and as there is not the slightest indication of what this may settle at when the coke-ovens are working again, they have decided to await developments, a policy which iron producers in most other areas seem to have adopted. For prompt delivery there is not much iron of any kind to be bought, although Scottish No. 3 at about 107s. 6d. per ton, delivered Manchester, Middlesbrough at 105s., and hematite at 98s., are still being offered in small parcels. These prices, however, are not an inducement for any one to buy except to satisfy very urgent needs. Bar iron makers are also proceeding cautiously in connection with forward business, and although the Lancashire Association prices of £11 10s. for Crown bars and £10 5s. for seconds are being quoted for forward delivery, it is improbable that manufacturers could be forced to accept big orders at those prices. For all practical purposes, stocks of Lancashire bars are exhausted, at all events, so far as the most common sizes are concerned.

Steel.

Prices that are being quoted here for continental steels are firmer again, Siemens plates now commanding £7 to £7 2s. 6d. per ton delivered to Manchester works for cash against documents; light plates, £6 10s.; joists £6 2s. 6d.; sections, £6 7s. 6d.; and steel bars, £6 5s. Steel bars and semi-finished steels generally are very difficult to buy, and prices are largely nominal, steel bars now being quoted at about £5 15s. per ton. There is no doubt that the time taken in effecting deliveries of continental materials is a factor that users are now taking seriously into account, for, although the demand can still be described as fair, a good deal more business would be done on this market if it were possible to get delivery in a reasonable time. The position of British steels remains much as it has been for some weeks. Whilst most makers are still disinclined to quote forward, there are others who are prepared to do so. Ship-plates at £8 5s. delivered Manchester, and basic steel bars at from £8 15s. to £9 per ton are quotations that are being given this week for delivery when rolling is resumed. Mills that are already doing a little are, as before, selling their outputs at premiums, although it is extremely doubtful if the prices that are being obtained are sufficient to cover the higher production costs. There is a big volume of business waiting to be placed, besides that which the rolling mills have already on their books. Assuming an early resumption of operations, there are many firms that have sufficient orders to keep them busy until after Christmas. In the case of galvanised sheets the Indian market is exceedingly slow in developing, and although there are a few inquiries reported this week, prices in most cases are below what British makers are prepared to accept. As it is, the quotation for 24-gauge Indian specifications has fallen another 5s. per ton, the present value being £16 f.o.b.

Scrap.

There is only a moderate business being done in non-ferrous metal scrap, although prices of most varieties keep steady. Cast aluminium is quoted at about £82; brass rod turnings at £40; gun-metal at £54; clean light copper at £57; braziery copper at £52; zinc at £25; and lead at £31 10s. per ton, for sorted materials, delivered to users' works.

BARROW-IN-FURNESS.

The Outlook.

It seems the irony of fate that the North-West district just when it has a chance of indulging in a period of activity should be held back from it by the lack of fuel. For the last six years or so trade has fluctuated and many times it has been checked by trouble in the coalfields. Now every maker is keen to get to work so that deliveries of orders, which are held, may proceed. Orders are on the books of one company for very little less than one hundred thousand tons, and the position of the other iron makers is much the same. If the coal industry can only be stabilised, and if the price of fuel is no higher than it was before the stoppage—it would be better if it could be less—then this district is in for a solid period of work such as it has not experienced for a long time. Naturally the local iron ore mines will share in this condition of things, and apart from the amount bought for local smelting, it is hoped that there will be better trade with other districts. Foreign ore, which has not been imported recently for obvious reasons, would soon be coming into ports adjacent to the works. As regards steel many orders are held, and each of the works is assured of a long run on contracts already placed, and it is certain that further orders would follow. The one bright spot in the district is the hoop works at Barrow, which continue to work on orders which are not scarce. Belgian billets are imported for these works. There have been heavy importations of coal recently, and last week there were cargoes from the following ports abroad, Norfolk, U.S.A., Newport News, Baltimore (2), Antwerp and Bremerhaven.

SHEFFIELD.

(From our own Correspondent.)

Railway Steel Making.

THE prospects of an early settlement of the coal dispute have again receded in consequence of the owners' reply to the Government proposal, and hopes of a speedy resumption of full activity in the steel trade are therefore again deferred. Nevertheless, Sheffield is carrying on to a considerable extent. It is having to pay dearly for its coal, but prices are not so high as they have been. The production of open-hearth steel is still on a small scale, but the restarting of half a dozen furnaces has proved beneficial and has enabled firms to provide material needed for the making of railway axles and tires. Fair quantities of these products are now being turned out, and, although not as large as usual, they are probably sufficient to meet the present limited demand. The orders now being given out by the British railway companies for rolling stock and steel for its repair are very few. There has been no resumption of work at the rail mills. It is not anticipated, however, that their idleness will result in any serious permanent loss of trade, as at this period of the year very few rails are required for either railway or tramway purposes, renewals being carried out, for the most part, in the spring.

Various Steel Branches.

The smaller mills and forges are running at from 50 to 75 per cent. of their capacity. They are deriving some benefit from the closing of the big works at the east end of the city and in the Rotherham district. There is an increase in the production of crucible steel, as a number of furnaces are now melting with German coke. This fuel is dear, costing as much as 67s. 6d. per ton, and, while fairly satisfactory, is not quite good enough for the production of the higher qualities of steel. A good deal of it is also being used in the local ironfoundries. Wire drawers, who had been enjoying a fair amount of activity until about a month ago, are now quiet in all sections. They have had to obtain most of their raw material from foreign sources as this country has produced very few rods during the dispute. Local makers of wire rope have been without orders ever since the coal stoppage began, but they are now receiving orders from the Nottinghamshire and Midland pits which have restarted work. When colliery operations generally are resumed, there should be considerable demands upon this branch of local manufacture, as pit ropes deteriorate even when not in use.

Railway Developments.

The London, Midland and Scottish Railway Company is to undertake a large programme of extension in the Staveley and Barrow Mill districts, near Chesterfield. Additions are to be made to the Staveley South sidings, and the present single line from Hall-lane Junction to Seymour Junction, a distance of 1¾ miles, is to be doubled, with additions on the Seymour side. About eight bridges are to be widened or constructed, alterations made to the platform at Staveley Town Station, and other works are to be carried out. The contract has been let to Logan and Hemingway, Ltd., of Doncaster, at a price of about £100,000. The work will involve the removal of over 100,000 cubic yards of earth during the excavations.

The Price of Gas.

The Sheffield trades have been greatly helped during these difficult months by the fact that ample supplies of gas and electricity were available. Hitherto, both undertakings have found it possible to continue their services at pre-strike prices, but now the gas company has been compelled, owing to the high cost of coal, to raise its charges somewhat. It gives notice that, as from the readings of the meter indices for the September quarter's accounts, the price to all consumers will be increased by two-fifths of a penny per therm, which is equivalent to 2d. per 1000 cubic feet. The new rates will be from 3s. 1d. to 1s. 10d. per 1000 cubic feet, according to the quantities consumed. The company had a large stock of coal when the strike commenced, and it has done remarkably well to continue its full supply for nineteen weeks without raising its price. The increase now put on is less than those which many other companies have had to impose, and Sheffield is still one of the cheapest places in the country for gas. At Birmingham, Manchester, Salford and Leeds, among other places, the price has been increased 6d. per 1000ft., and at Bradford 3d.

A Cutlery Improvement.

The position of the cutlery trade is rather stronger, as there is not only a slight revival in the home demand, but the overseas markets are sending large orders, which in the aggregate are not far below the bookings at the corresponding period of last year. The improvement extends also to plate, but there are few large contracts for table furnishings, and best quality goods are in poor demand. In the tool sections generally only quiet conditions are reported, though a few makers are busy. The overseas demand is moderate. It had been intended to hold a cutlery and light steel products exhibition in London this year, but it is now announced that the project has been abandoned, owing to the effect of the prolonged coal strike on Sheffield.

A Dockyard Lease.

The Admiralty has leased for a term of years a portion of Pembroke Dockyard to Thos. W. Ward, Ltd., the well-known Sheffield firm of shipbreakers. This is in accordance with the Government policy of assisting the workmen who are thrown out of employment by the closing down of the dockyard, and it indicates that the firm has acquired some of the tonnage which was recently offered by the Admiralty on the understanding that preference would be given to firms who could absorb dockyard labour. Operations are to start at once.

Company Reports.

The Sheffield firm of Thos. W. Ward, Ltd., has, by the way, just announced a final dividend on its ordinary shares of 5 per cent., making a total of 7½ per cent., tax free, for the year ended June last. For the previous year the distribution was 10 per cent. tax free. Less satisfactory, but on the whole not surprising, notices have been issued by two other local companies. The directors of the Sheepbridge Coal and Iron Company, Ltd., state that, in view of the heavy losses incurred in consequence of the miners' strike, they have decided to pay the final dividend on the preference shares, but to defer the question of a further dividend on the ordinaries, on which an interim of 2½ per cent., less tax, was paid in February. Cammell Laird and Co., Ltd., has decided not to pay an interim dividend on either its preference or ordinary shares.

The Spanish Decree.

The Sheffield Chamber of Commerce has taken a firm stand in opposition to the recent Spanish Royal Decree, the effect of which will be practically to kill the city's steel trade with Spain; and it has put down a strong resolution on the agenda of the meeting of the Associated Chambers, which is to be held at Hull next week. The Sheffield Chamber asks the Association to view with grave concern the Decree, which it regards as an unfriendly interference with the trade of British manufacturers, preventing them from carrying out contracts entered into in good faith; unreasonable and unjust to merchants and exporters; a serious hardship to merchants' agents and branch houses in Spain; and a severe handicap to all users of steel in Spain. It requests that the Government should lodge an emphatic protest with the Spanish Government against this unfair treatment of the manufacturers and merchants of a country which constitutes one of the best markets for Spanish wines, fruit and other produce, and should ask for the withdrawal of the Decree.

NORTH OF ENGLAND.

(From our own Correspondent.)

Against National Agreement.

THE insistence of the Northumberland and Durham coalowners upon district agreements as against a national settlement has occasioned little surprise in coal trade circles in the North of England. The conditions in these counties are widely different from those prevailing in many other coal-producing centres. The output of Northumberland is mainly, and that of Durham largely, for the export trade. Both have to meet foreign competition, foreign market requirements, and the seasonable conditions of shipping, and under such conditions it is contended that a local agreement, made with local knowledge and interests, is bound to be more satisfactory to all concerned than a national agreement. When district agreements were in operation, the coal trade of Durham and Northumberland reached a high general level. Foreign markets were captured, shipping was developed, wages attained a high standard, and the coal hewers in the two counties secured the shortest working shift in the industrial world. Under a national agreement, however, the industry has gone from bad to worse. Take Durham, as an example. In February last the average selling price of coal was 3s. 3d. a ton less than the cost of production. Between July, 1914, and April, 1926, Durham coal-getters' wages increased by 65·5 per cent., but the wage cost per ton had increased by 83·5 per cent. That was due to the reduced output per unit of labour, and to the uneconomical shifts and other methods insisted upon by the Miners' Federation. In spite of much discouragement, the Durham coalowners have spent enormous sums of money on improving the working conditions of the men, and modern cutting machinery has been installed in many collieries. The improvement in this respect is reflected in the fact that in 1914 only 4·7 per cent. of the coal was machine cut, whereas the percentage in the first quarter of 1926 was 34. Yet the output per man was only 18·6 cwt. this year, compared with 19·6 cwt. in 1914.

Cleveland Iron Trade.

Business to any extent is still impossible in the Cleveland pig iron trade, but there is a substantial inquiry which is taken to indicate that the placing of considerable

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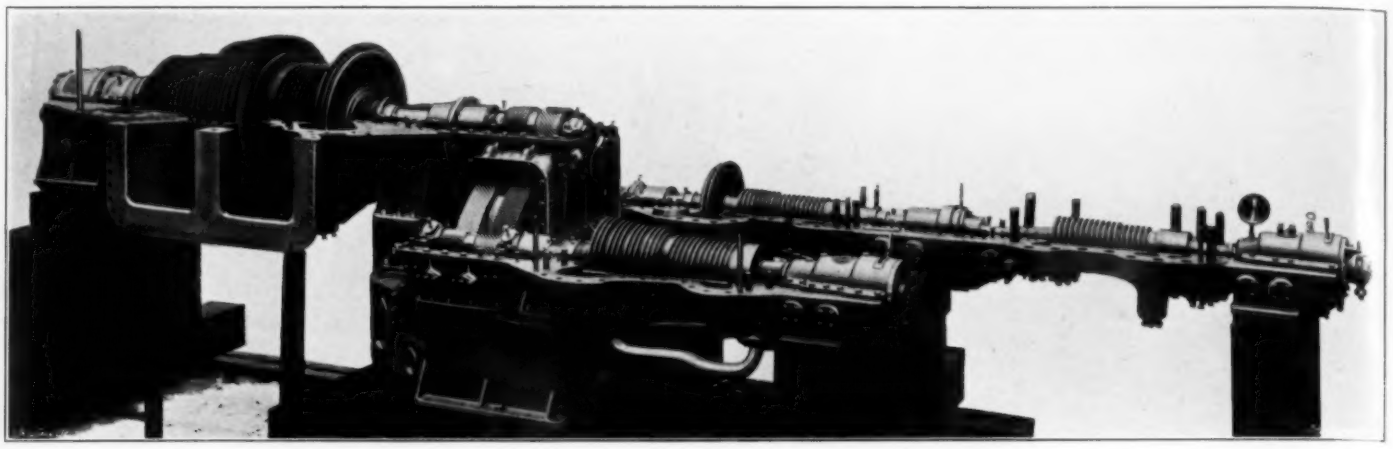
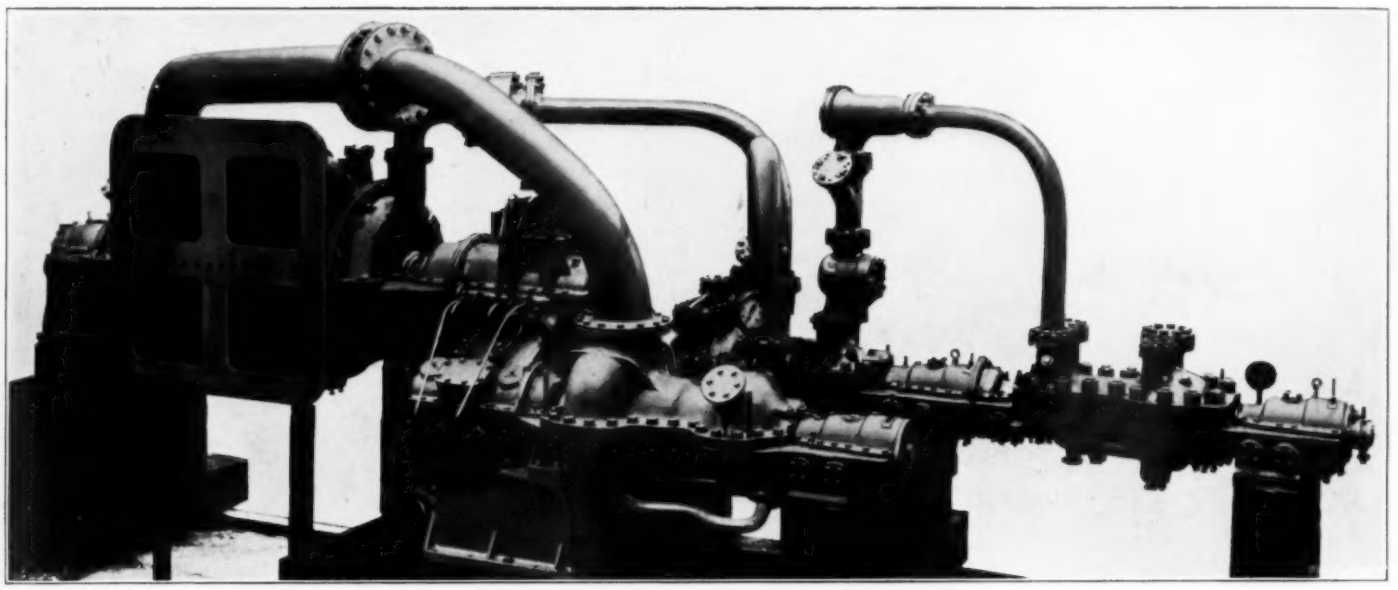
PROPELLING MACHINERY OF THE HIGH-PRESSU

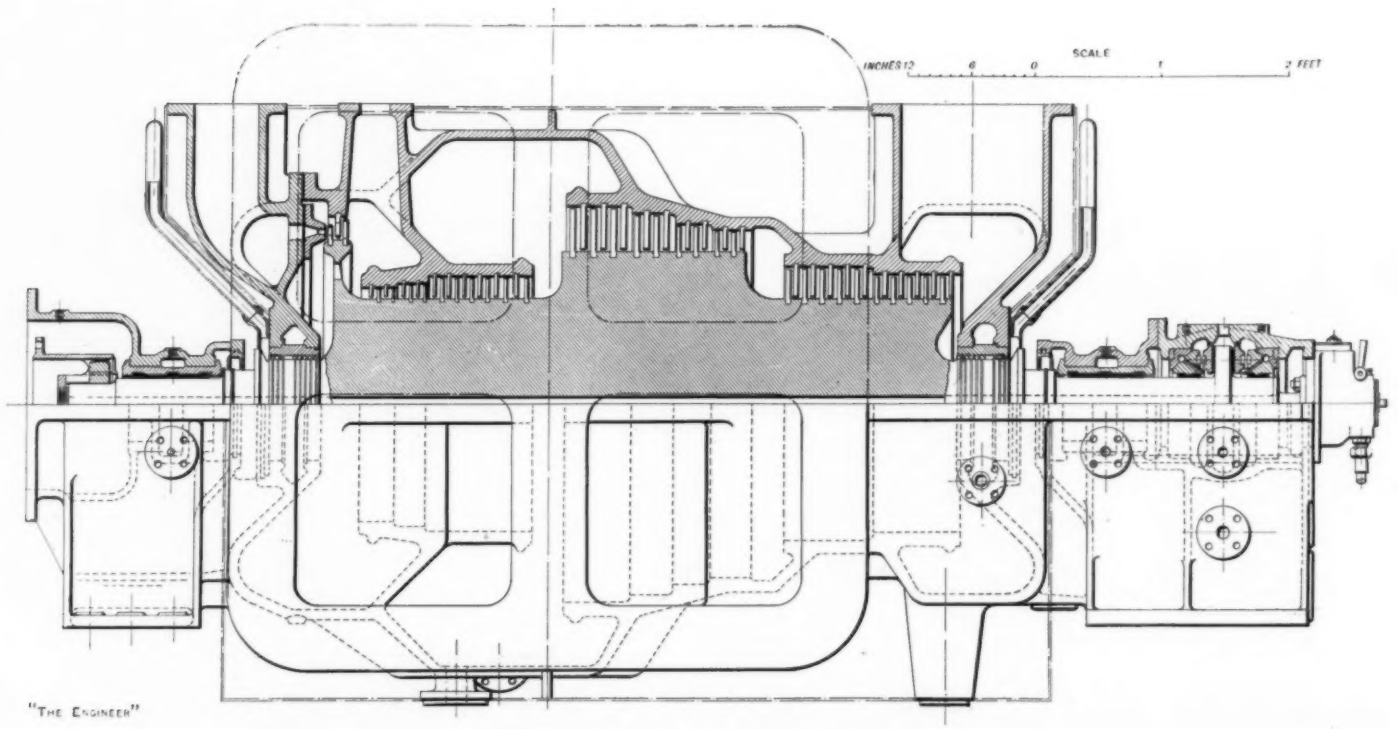
THE PARSONS MARINE STEAM TURBINE COMPANY, L



PORT TURBINES AND REDUCTION GEARING WITH UPPER CASINGS REMOVED



PORT TURBINES AND REDUCTION GEARING COMPLETE



LOW-PRESSURE AHEAD AND ASTERN TURBINE

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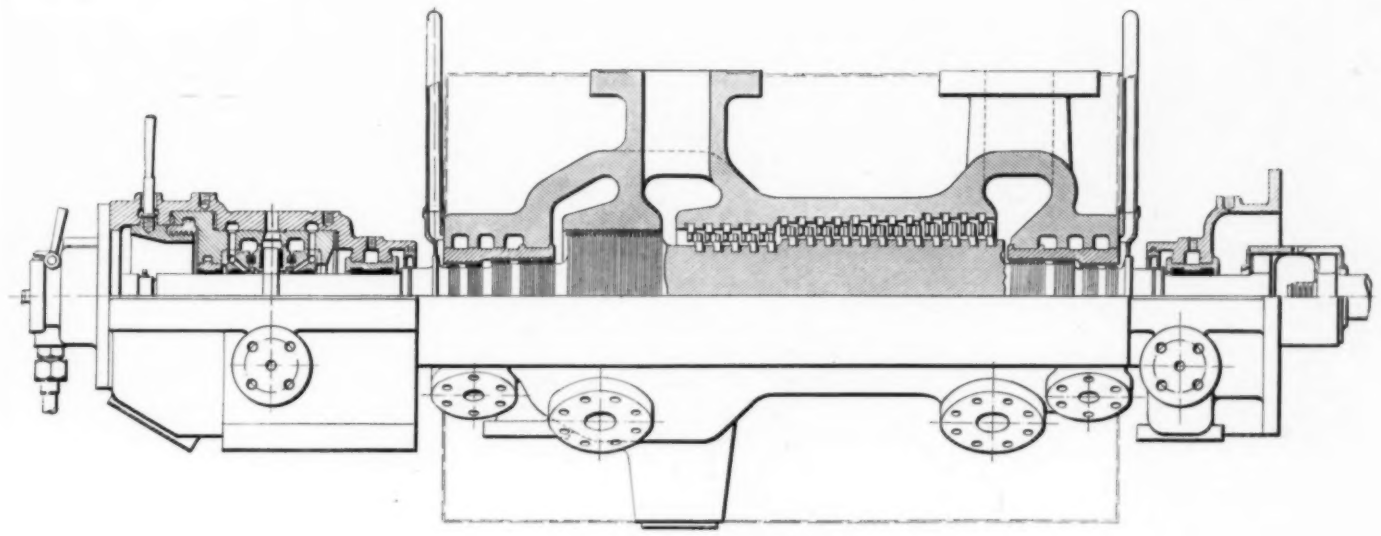
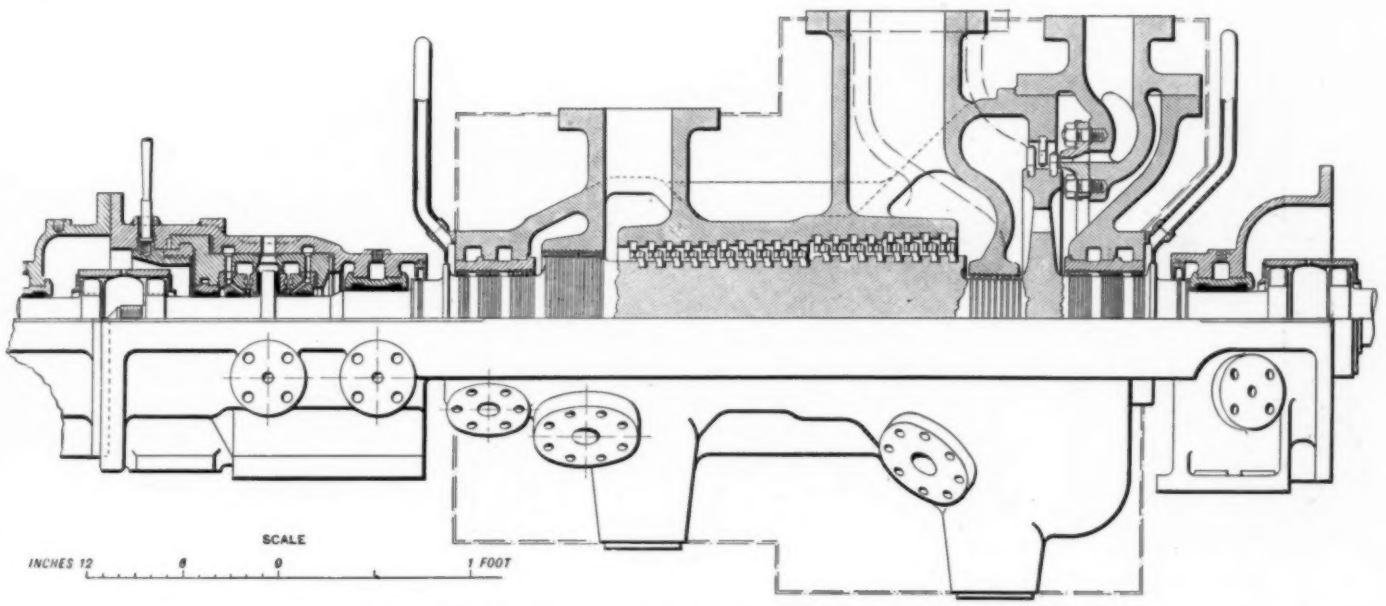
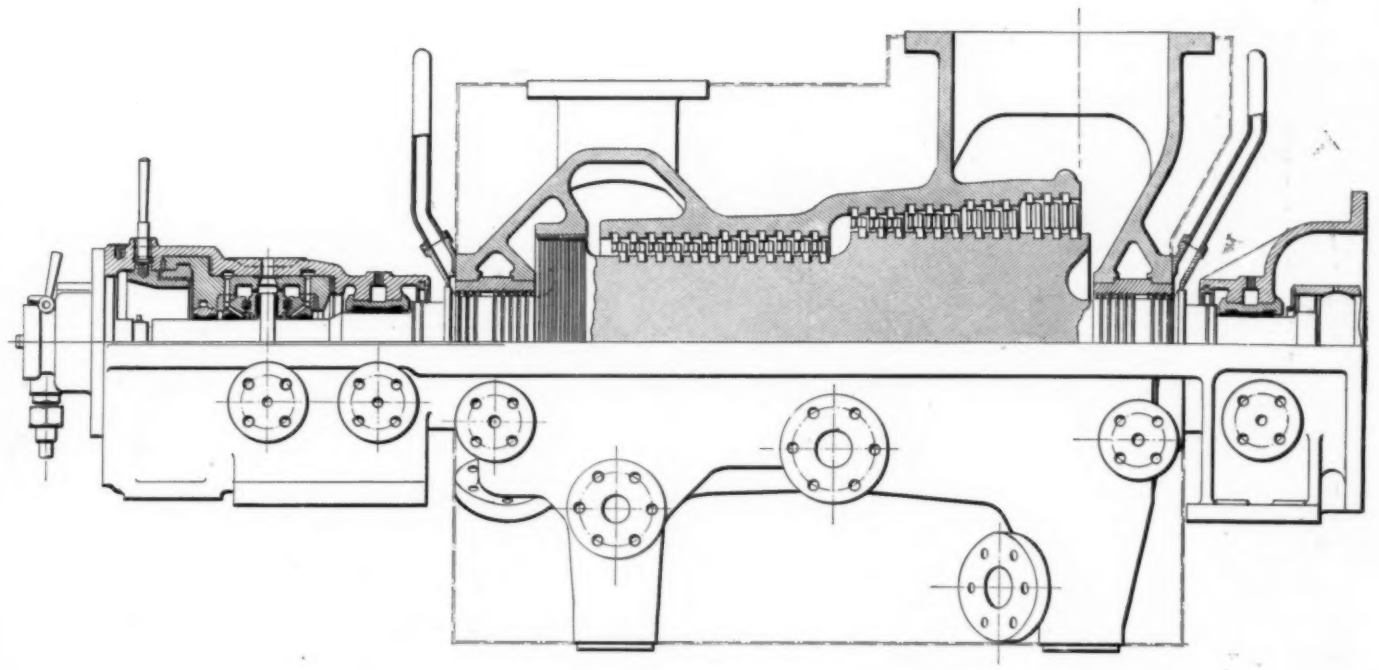
BINE COMPANY, LTD., WALLSEND-ON-TYNE, ENGINEERS



HIGH-PRESSURE AHEAD TURBINE



FIRST INTERMEDIATE-PRESSURE AHEAD AND HIGH-PRESSURE ASTERN TURBINE



SWAIN Sc.

SECOND INTERMEDIATE-PRESSURE AHEAD TURBINE

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tonnage is likely speedily to follow resumption of work at the collieries. There is a continued feeling of uncertainty as to the future trend of quotations, but the opinion prevails that renewal of regular ample supplies of locally produced coal and coke would enable traders to form ideas of autumn market values. Much complaint is still heard that current quotations are unremunerative, and in several branches manufacturers are unlikely to set idle plant in motion until they have reason to anticipate either an advance in prices or a reduction in the cost of production. Makers report that they have no more iron for sale this month, and have advanced prices for October delivery. This does not argue any degree of optimism regarding an early resumption of work, and it must be confessed that peace hopes are fading. Hence, there are few buyers negotiating for October delivery even at the enhanced prices. For the most part, consumers of pig iron are forced to rely upon foreign supplies, and imports from abroad are very heavy. This foreign iron is about 10s. per ton below Cleveland iron, but there are still many who would prefer the latter if they could get it. Cleveland prices to home consumers are :—No. 1 foundry, 94s. 6d.; No. 3 G.M.B., 92s.; No. 4 foundry, 91s.; and No. 4 forge, 89s. 6d. per ton. In every case 6d. per ton extra is asked for export orders.

Hematite Pig Iron.

The output of East Coast hematite is now confined to one blast-furnace, and supplies are consequently scarce. Still, there is no great pressure for hematite iron, and sellers have not been able to advance quotations beyond 83s. for mixed numbers and 83s. 6d. for No. 1 quality.

Iron-making Materials.

Best Rubio ore is nominally 21s. 6d. per ton c.i.f. Tees, but not a ton of foreign ore has entered the Tees for about six weeks, and business is completely suspended.

Manufactured Iron and Steel.

Makers of finished iron and steel are still selling odds and ends from stock, and there are a few mills still working on special orders. But for these latter considerably higher prices must be paid, as fuel costs are almost prohibitive. With regard to post-strike orders, steel makers appear to have booked all they can, and until the position is less obscure, they are not disposed to commit themselves. The galvanised sheet mills are still working and continue to command £17 for prompt deliveries of galvanised corrugated sheets, 24 gauge, with black sheets at £11 5s. per ton.

The Coal Trade.

While merchants are viewing the forward prospects favourably, they are anxiously awaiting the outcome of the negotiations between the Government, the owners, and the men's representatives. The opinion is favourable that a settlement will be reached this month, but, as the actual period is so indefinite, they cannot enter into any firm negotiations. Hopes are expressed from reports coming to hand from various mining districts, that some of the larger collieries may be able to get to work next week. At the moment there appears to be a good prospect of securing a fair amount of trade for the last quarter of the year, but local merchants will have to get in quickly to prevent the consumer protecting himself by covering in other markets. There is no slackening, however, in the booking up of foreign coals. Consumers, while hoping to get British coal at an early date, show no hesitation in covering their most urgent requirements, and for shipments up to November there is a brisk inquiry and a fair number of transactions are being effected.

SCOTLAND.

(From our own Correspondent.)

The Effects of the Strike.

THE passing of time adds to the records of business lost through the general strike and the coal dispute, and the report of the results of the past year's trading at Glasgow Harbour presents a good example. In the financial statement read at a meeting of the Clyde Navigation Trustees it was pointed out that the state of affairs existing in the closing months of the financial year, which coincided with the first weeks of the strike, made all the difference between results of a high level and a loss in revenue compared with 1924–25. The rates levied at the harbour were unchanged, but there had been a loss in revenue amounting to £65,094, almost wholly accounted for by the drop in trade since the beginning of the strike. Among other items it was stated that coal exports showed a decrease of 250,000 tons, iron ore imports were 136,000 tons down, and fuel and Diesel oil imports had decreased by nearly 40,000 tons.

Steel and Iron.

So far as the steel works are concerned, only those producing bars, sheets and light material generally, are in operation at present, and at some of them production is hindered by the unsuitability of foreign coal for certain purposes. Inquiries have not expanded and business is very limited generally, but producers continue to quote very firm prices. Sheet makers, however, are well booked up, and are as busy as circumstances will permit. The production of bar iron and re-rolled steel is very limited, and bookings, as a rule, are in advance of output.

Pig Iron.

Operations in pig iron are restricted to very moderate quantities. Stocks of some brands of foundry quality are completely exhausted, and transactions in those available are difficult to conclude owing to differences of opinion between buyers and sellers on the question of prices. Holders are realising good prices for any available material when sales are completed.

Coal.

As the position is unchanged in the Scottish coalfields, the amount of fuel being raised at present is practically negligible, and without effect on the market for home coal, which remains inactive.

Foreign Coal.

The market for foreign coal retains a firm aspect. Consumers have shown more inclination to consider requirements over a period, but importers will not commit themselves to anything apart from fuel available for prompt shipment. Approximate quotations are as follows :—Silesian screened, 51s. 6d.; Westphalian unscreened, 48s. 6d.; American unscreened, 48s. 6d.; all per ton f.o.t. Reports state that a considerable business is being done in Westphalian foundry coke at from 46s. to 48s. per ton free on wagon, and that buyers seem prepared to buy for delivery well into October.

Locomotive Orders.

The North British Locomotive Company, Ltd., of Glasgow, has secured an order for twelve superheater tank locomotives of the 2–6–4 wheel arrangement for the broad gauge lines of the Madras and Southern Mahratta Railway.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Dispute Outlook.

THE outlook for an early settlement of the coal dispute appears to be less promising, and yet hopes are not abandoned that the stoppage of work in the coalfields will come to an end by the beginning of October. It is true that the coalowners have declined to negotiate nationally, and insist on district settlements, while the miners' Executive has resolved to resist this course and to await the next move of the Government. On the face of things it would appear that the end is as far off as ever, and yet the feeling prevails that if only the Government will step aside and leave the coalowners and the men to settle, an agreement will be come to. When the men's leaders realise that the Government are determined to adopt this course, it is believed that they will assume a very different attitude to that adopted at present. At the same time, it cannot be denied that some very quick work will have to be done if district settlements are to be arrived at by the end of this month. The time is getting on, and there will have to be district conferences, and probably a ballot of the whole of the rank and file. So far as South Wales is concerned, it is very difficult to share the optimism of those who look for a termination of the struggle by the end of September ; the middle of October seems, at the earliest, a more likely date.

Welsh Coalowners' Decision.

The coalowners in this district met at Cardiff on Friday of last week to consider the request of the Government that the district associations of coalowners should authorise the Mining Association to enter into negotiations with the Government and the Miners' Federation for the arrangement of a national agreement. The resolution of the South Wales coalowners could not be more emphatic in declining the request. The Association decided that it was definitely opposed to any form of national agreement or national negotiations, and unanimously declined to confer upon the Mining Association of Great Britain any power or authority to discuss, negotiate or enter into any agreement whatsoever relating to the terms and conditions of employment of the workmen in this coalfield.

Conditions of Trade.

Foreign coal continues to come in to local ports on a fairly active scale. Last week the total was again in the neighbourhood of 60,000 tons. There has been on an average twelve to fifteen steamers discharging at ports between Newport and Swansea. By far the greater quantity of coal has come from America, but it is noteworthy that a cargo of South African coal, amounting to 7000 tons, has been brought to Cardiff by the ss. City of Batavia for the Great Western Railway Company. Continental coals continue to advance in price almost every day, Westphalian unscreened being now about 45s. to 46s. c.i.f. South Wales, and American run-of-the-mine 47s. to 48s. c.i.f. Reports to hand show that many continental producers are now full up with orders for the remainder of this year. One feature is the strength of the freight market for tonnage from the United States to the United Kingdom. Whereas a short time ago rates were in the neighbourhood of 15s. to 16s., the market has now advanced to round about 22s. 6d. for prompt tonnage. In fact, this figure has been improved upon for a medium-sized steamer, and it is strongly believed that rates will go to 25s. before very long. Quite a considerable amount of tonnage has been taken up with end of October cancelling, to load coals from the United States, and in a few instances with early November cancelling, so that if things go on at the present rate it is quite possible that American coals will be coming into this country practically right up to the end of this year. There is not much that is fresh so far as the import trade of this district is concerned. The pitwood trade is virtually at a standstill, but partly manufactured iron and steel goods have been arriving on a fair scale. Last week the quantity was rather over 30,000 tons, as compared with just under 19,000 tons for the previous week. The conditions in the ship-repairing industry are really deplorable. They have been bad enough for the past year or more, but it is doubtful whether they have been worse than during the last week or two. On Monday last, taking the whole of the dry docks at the six ports of Cardiff, Penarth, Barry, Newport, Swansea and Port Talbot, there were only nine vessels in them. One combine which can accommodate over a dozen steamers at a time in its dry docks had not a single steamer.

Looking Ahead.

There was a meeting of colliery sales agents at Cardiff towards the end of last week, when the whole position of trade was reviewed and prospects discussed, more especially in relation to prices. It was eventually decided to revive the divisional committees representing (1) Cardiff coals, (2) steam coals, (3) dry coals, and (4) Monmouthshires. These committees will meet separately, after which the respective chairmen will meet and discuss the situation generally. There has been a little inquiry lately for coals for delivery when work is resumed in this coalfield. Very few colliery undertakings will make any definite offer at this stage, but it is reported on the market that some undertakings are indicating 27s. 6d. for best Admiralty large steams, 26s. 6d. for superior Monmouthshire large, and 17s. 6d. for best quality smalls.

Tin-plate Trade.

It is recorded that out of a total of 430 tin-plate mills in South Wales and Monmouthshire, 192 are working.

Steel Works Contract.

Under this heading in my letter last week I reported that Braithwaite and Co. had secured a contract for the supply of steel water pipes for the Government of one of the South American States, and that the pipes would be made at the works of Guest, Keen and Nettlefolds. This statement requires emendation in so far that the pipes will be made, not of steel, but of Armco ingot iron, and that the plates will be rolled at the works of Guest, Keen and Nettlefolds, to be made subsequently into pipes by Messrs. Braithwaite, partly in this country and partly in South America.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has been successful in obtaining a contract from Geo. Thompson and Co., Ltd., the Aberdeen Line, West Central Dept., Royal Albert Dock, London, until the end of the year for the supply of incandescent lamps.

RICHARD GARRETT AND SONS, Ltd., have been informed that their tender to the West Hartlepool Corporation Tramways for the supply of twelve "Garrett" low-loading line electric trolley buses has been accepted, including their tender for the overhead equipment. The whole contract amounts to about £25,000.

PEMBROKE DOCKYARD.—We understand that the Admiralty have leased for a term of years a portion of Pembroke Dockyard to Thos. W. Ward, Ltd., of Sheffield. This is in accordance with the Government policy of assisting workmen who are thrown out of employment by the closing down of the dockyard at Pembroke, and indicates that Messrs. Ward have acquired some of the tonnage which was recently offered by the Admiralty on the understanding that preference would be given to firms that could absorb ex-dockyard labour. Operations are to commence at once.

LOUGHBOROUGH COLLEGE.—A new feature of this year's enrolment of students at Loughborough College will be the admission of men who have gained the first awards under the Empire Scholarship scheme established by the Governors in 1925. The competition for these scholarships, which carry an award of £75 per annum for the full diploma course, was particularly keen. Candidates hailed from Canada, South Africa, Ceylon and Palestine, in addition to the homeland. The successful men come from Cheltenham, Banbury, Ashby-de-la-Zouch, Epsom, and Jerusalem.

MOTOR VESSEL FOR THE NEW ZEALAND GOVERNMENT.—Further to the note published last week from our Sheffield correspondent, with regard to the new motor vessel for the Pacific Islands Administration, which has been ordered by the New Zealand Government from the Dublin Dockyard Company —Vickers, Ireland, Ltd.—we learn from Vickers-Petters, Ltd., that the propelling machinery will consist of two sets of the firm's new "C" type heavy oil engines. The "C" type engine was described in our Special Supplement of November 20th, 1925, issued on the occasion of the Shipping, Engineering and Machinery Exhibition at Olympia. A feature of the new design is the introduction of a completely cooled spherically shaped combustion space. The hot bulb is eliminated and the ignition of the fuel is effected by the compression temperature in the engine cylinder.

SPECIAL LECTURES.—A series of popular talks on "Travel, Science and Invention" (with experimental demonstrations or illustrated by original lantern slides) has been arranged in aid of King Edward's Hospital Fund for London. Amongst these lectures we may note that on Thursday, October 7th, Mr. H. L. Baird, the inventor of television, will speak on "Seeing by Wireless," at the Royal Institute of British Architects, Conduit-street, W.; on Thursday, October 14th, Air Vice-Marshal Sir Sefton Brancker, K.C.B., will discuss "Flying To-day and To-morrow," at the same address ; and that on Friday, November 26th, Dr. Eser Griffiths, F.R.S., will deal with "The Romance of Refrigeration," at the Fivie Hall, Polytechnic, Regent-street. All the lectures will be delivered at five o'clock, and tickets of admission will be 2s. 6d. They can be obtained from the Secretary, King Edward's Hospital Fund for London, 7, Wallbrook, E.C. 4, or at the entrance.

ELECTRIC CABLE SOLDERING SOCKETS.—British Standard Specification No. 91 was originally issued in 1921, and has now been revised so as to make better provision for sockets for use with either paper-insulated or rubber-insulated cables. The revised specification is otherwise very similar to the old edition, with the exception that a few additional sizes are included in the list of cast lug sockets and tubular lug sockets. A certain number of these sizes are marked as primary sizes and are recommended for adoption wherever possible, the remaining sizes being marked as secondary sizes and are intended to be used only in cases where it is not immediately convenient to employ primary sizes. In this way it is hoped to be able at some future time to reduce the number of standard sizes to the present number of primary sizes, thus considerably simplifying the keeping of stocks. Each size of lug socket is obtainable in three types, according to the angle of inclination of the palm of the socket. Copies of this publication (No. 91–1926) can be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 2 6	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 3 0	4 3 0
No. 1	4 3 6	4 3 6
Cleveland—		
No. 1	4 15 0	4 15 6
Silicious Iron	4 15 0	4 15 6
No. 3 G.M.B.	4 12 6	4 13 0
No. 4 Foundry	4 11 6	4 12 0
No. 4 Forge	4 11 0	4 11 6
Mottled	4 10 6	4 11 0
White	4 10 6	4 11 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0 to 3 10 0	
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 6 (*a*) / 4 12 0 (*b*) / 4 16 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 10 0 to £12	11 0 0
Best	—	—
N.E. COAST—		
Common Bars	11 5 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ¾in.	11 5 0 to 12 5 0	
Sheets (Gal. Cor. 24 B.G.)	— £17 5 0 to £18 5 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 5 0	—
,, (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 2 6	—
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 10 0	
Billets and Sheet Bars	6 2 6 to 6 7 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	7 7 6 to 8 17 6	
Joists	7 7 6 to 8 17 6	
Tees	8 7 6 to 9 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/6 to 23/-
Block Tin (cash)	307 15 0
,, (three months)	297 15 0
Copper (cash)	58 17 6
,, (three months)	59 12 6
Spanish Lead (cash)	31 18 9
,, (three months)	31 11 3
Spelter (cash)	34 3 9
,, (three months)	34 7 6
MANCHESTER—	
Copper, Best Selected Ingots	66 7 6
,, Electrolytic	67 10 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	33 15 0
,, Foreign	32 10 0
Spelter	34 12 6

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 to 1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 0 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£37 0 0	12/6
,, ,, 1 p.c. ,,	£43 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£17 0 0 scale 6/- per unit	
,, Vanadium	14/9 per lb.	
,, Molybdenum	5/3 per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

(*Prices nominal.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/9
,, ,, Ell	16/6
,, ,, Splint	16/6 to 17/-
,, ,, Trebles	15/9
,, ,, Doubles	14/- to 14/6
,, ,, Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
,, ,, Jewel	17/- to 17/6
,, ,, Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
LOTHIANS	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

	Inland.
(8) N.W. COAST—	
Steams	*No quotation.*
Household	,, ,,
Coke	,, ,,
NORTHUMBERLAND—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
DURHAM—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-
SHEFFIELD	(*Nominal: none on offer.*)
Best Hand-picked Branch	31/- to 34/-
Barnsley Best Silkstone	28/- to 30/-
Derbyshire Best Brights	26/- to 28/-
,, ,, House	24/- to 25/-
,, ,, Large Nuts	17/- to 20/-
,, ,, Small	12/6 to 14/-
Yorkshire Hards	17/- to 19/6
Derbyshire Hards	16/- to 19/-
Rough Slacks	10/- to 12/6
Nutty Slacks	7/6 to 9/-
Smalls	3/6 to 6/-
Blast-furnace Coke (Inland)*	—
,, ,, (Export) f.o.b.	16/- to 17/-

(9) SOUTH WALES.

(*All prices nominal.*)

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary ,,	16/- to 17/-
Washed Nuts	19/- to 20/-
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	26/6 to 27/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Industrial Position.

HOPE of a revival in trade has been encouraged in France by the belief that the Government is steadily working its way to a final stabilisation and that, while manufacturers will undoubtedly pass through troublous times before they emerge from the present crisis, there is, nevertheless, every reason to expect that their patience will eventually meet with its due reward. As, however, despite the Government's efforts, the franc has been unable to shake off its torpor, the public confidence in the official measures is perceptibly weakening. It is now becoming clear that national retrenchment will do little without international co-operation, and the iron, steel, and engineering trades are therefore looking forward with particular interest to the efforts being made to carry out a European reconstitution. The official reconciliation with Germany is expected to provide satisfactory results in this direction. If the Rail Union can be taken to illustrate the probable effects of European co-operation, it is fairly certain that the grouping of interests will be profitable to manufacturers. The prices of rails have been advanced nearly 300f. a ton above the former basis quotation, and in view of this fact consumers are looking forward with some anxiety to the attempted reorganisation of the iron and steel industry. The efforts to effect this organisation are extremely laborious, and even in the Rail Union there is already some dissension, one of the leading French rail-making firms having lodged a protest against being deprived of a large share of its South American custom which it had acquired after many years of patient enterprise. It is, nevertheless, hoped that the improved relations amongst European countries will facilitate the carrying out of negotiations for the constitution of the Steel Union, as well as of a general economic reconstruction, particularly in the way of commercial arrangements and the suppression of prohibitions and other impediments to commercial exchanges. It appears that the Belgian steel makers have at length come to an agreement regarding the conditions under which they can adhere to the Steel Union, and have undertaken to sign the Cartel at the next meeting on condition of their quota being increased to 290,000 tons, the additional 25,000 tons to be taken out of the quantity which was to be distributed between Poland and other countries. The success of the negotiations will therefore depend upon whether France, Germany, and Luxemburg will agree to these new Belgian demands. If the agreements are signed at the forthcoming meeting it does not follow that there will be an immediate improvement in the steel trade. Prices are still advancing without there being any increased demand, and under present conditions the higher costs are having the effect of restricting consumption. A case in point is the extremely critical position of wagon builders. The railway companies are purchasing nothing, and the State proposes to order from Germany on account of reparations another lot of twenty metallic postal vans. The necessity of carrying out economies is having a serious effect upon some of the engineering trades.

Paris Water Supply.

The Paris Municipal Council has not abandoned the idea of obtaining from the practically inexhaustible subterranean supplies in the Vals de Loire all the water necessary to satisfy the growing requirements of the city. It is the only scheme that solves completely the problem of future supplies. The consumption increases so rapidly that it overtakes new sources of supply before the works are finished, and the many undertakings that have to be carried out to procure limited supplies are proving very costly. Moreover, there are no new supplies of any importance available, apart from the construction of vast reservoirs in the upper valley of the Seine, where it is by no means certain that the stagnant water would be of suitable quality. Therefore, in order to meet the objections of the populations in the valley of the Loire, who affirm that the raising of the subterranean water would affect the river level and reduce the supplies available for local needs, the municipal engineers propose to construct a vast reservoir which would regularise the Loire. The scheme is condemned by the Orleans Chamber of Commerce, which regards it as perfectly futile, and in common with all the other local authorities it objects to the Paris Municipal Council tapping the subterranean supplies. It appears, therefore, that the Paris engineers are no nearer a solution of a particularly arduous problem.

Dunkirk.

The scheme for enlarging the port of Dunkirk provides for an inland port which will allow of 350-ton barges arriving there from the canal system in the Nord and the Pas de Calais. For this purpose the Chamber of Commerce will take over the canalised river Colme, which will be deepened, as well as the river Aa, and one effect of the works to be carried out will be to suppress the floods which often prevent the Aa from being utilised for quite long periods. The cost of the undertaking will be about eight million francs, one-half of which will be borne by the Chamber of Commerce and one-half by the State. The distance between St. Omer and Dunkirk will be reduced by 7 kiloms. and there will be 27 kiloms of canal without locks.

Shipbuilding.

Notwithstanding complaints of a stagnation in the shipbuilding industry, some of the shipyards have been able to secure foreign orders, and more activity is provided by the increased private participation in the execution of the programme of naval construction. During the second quarter of the present year thirty-four ships with a total tonnage of 153,955 tons were built, as compared with thirty-five ships with a tonnage of 155,965 tons in the first quarter. A few motor ships were constructed, but in this department the French shipyards are still a long way behind those of some other countries.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

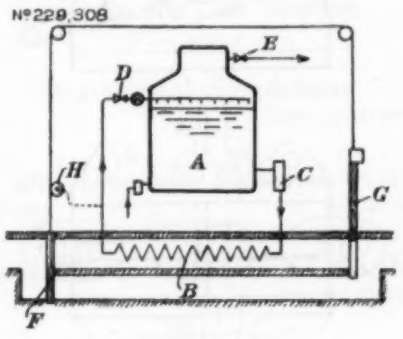
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

229,308. February 11th, 1925.—APPARATUS FOR STEAM GENERATION, F. Marguerre, Collinstrasse 23, Mannheim, Germany.

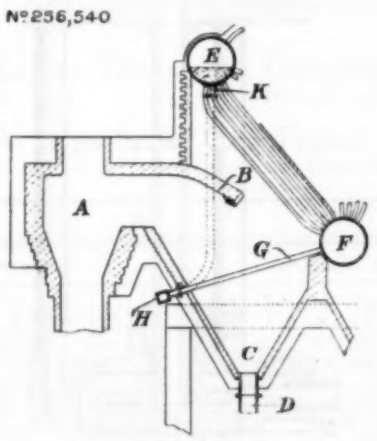
This invention is concerned with steam generators in which the water is kept under such a pressure that steam is not evolved within the heating system and is only produced exteriorly when the pressure is reduced. The water is circulated through an evaporator A and a heater B by means of a pump C. At D there



is a throttling valve which reduces the pressure and encourages the vaporisation of the water, so that steam is supplied at E. In the flues of the heating chamber there are two dampers F and G, of which G is the heavier. In the event of the pump failing and the circulation of the feed water ceasing, the catch H is tripped (by some mechanism not precisely specified) and the dampers change places, so that the hot gases are by-passed round the heater B.—*August 11th*, 1926.

256,540. April 30th, 1926.—WATER-TUBE BOILERS, The Stirling Boiler Company, Ltd., 32, Farringdon-street, London, E.C. 4, and S. Wallis, 33, Winn-road, Lee, London, S.E. 12.

This invention relates to boilers used in connection with refuse destructors. In the drawing A indicates the upper end of a refuse destructor from which the flame, hot gases and dust pass to the steam generator. B is an overhanging arch by which the flame, gases, dust, &c., are deflected downwardly into a large dust hopper C fitted with an outlet D for dust at its lower end. The hopper C is the first of a series, the number of which is dependent on the size of the steam generator, of which E and F

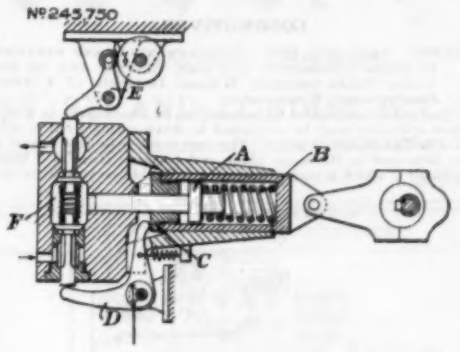


denote the front upper and lower drums. The gases, dust, &c., are deflected downwards by the overhanging arch B and are deprived of their heat to a considerable extent by the provision of a water screen indicated by G and composed of a series of water tubes extending across the hopper to a transversely extending header H which in turn is connected by means of downcomers K to the front upper drum of the boiler. The tubes G may be spaced quite closely together, say, about 6in. centres. As the water screen is preferably placed close to the point of admission of the flame, &c., and great evaporation ensues, the tubes of the screen are preferably steeply inclined, as shown.—*August 12th*, 1926.

INTERNAL COMBUSTION ENGINES.

245,750. December 11th, 1925.—IMPROVEMENTS IN OR RELATING TO FUEL PUMPS, Sulzer Frères Société Anonyme, of Winterthur, Switzerland.

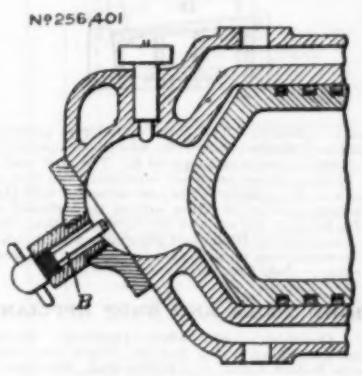
The improved fuel pump referred to in this specification is of the type which embodies a fuel accumulator chamber and is furnished with a spring-loaded plunger, the spring being disposed between the plunger and the hollow crosshead piece, which is driven by the usual excentric strap. On the outstroke of the plunger A a constant amount of fuel is drawn through the suction valve into the accumulator chamber F. On the return stroke of the plunger the suction valve is held open by the governor controlled tappet D, and it is closed near dead centre when the end of the crosshead piece C comes into contact with the upper part of this tappet. During the first part of the return stroke the oil fuel is expelled through the suction valve, but as soon as this valve closes the plunger A remains stationary and the crosshead C continues to move forward, compressing the spring B and thereby storing up energy, which is released when the delivery valve is opened by the tappet E. As long as the delivery



valve remains open fuel continues to be delivered to the cylinder. —*August 12th*, 1926.

256,401. August 19th, 1925.—IMPROVEMENTS RELATING TO THE STARTING ARRANGEMENTS OF INTERNAL COMBUSTION ENGINES, Sir K. I. Crossley and Wilfred Webb, of Openshaw, Manchester, Lancashire.

This invention relates to the starting of internal combustion oil engines using heavy fuel oil by an igniter which does not ignite spontaneously under ordinary atmospheric conditions, but will ignite spontaneously in the air which is compressed in the combustion chamber of the engine. The tip of the igniter B

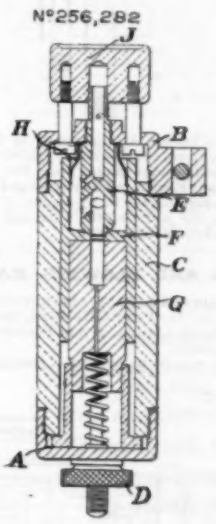


is formed of a mixture consisting of camphorated pyroxylin or other suitable material which will ignite freely at the low temperature necessary, while the main body of the igniter may be made of paper impregnated with saltpetre or other similar material. This part of the cartridge will burn for a sufficient length of time to ignite the oil spray and air at successive ignition periods until the temperature towards the end of the compression stroke is high enough to enable firing to continue without further assistance.—*August 12th*, 1926.

ELECTRICAL APPLIANCES.

256,282. February 3rd, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRICAL CUT-OUTS, Bob. Bell, of 4, Portland-place, Halifax, and William Henry Illingworth, of 1, Ruskin-terrace, Lee Mount, Halifax, Yorkshire.

This invention relates to that type of electrical cut-out in which the current is normally carried between two conductors by a mercury column of restricted area, which is broken when the current exceeds a predetermined value and is only re-established when the integrity of the column has been restored. The device illustrated is designed for currents between 5 to 180 ampères. It consists of two end caps A and B and an intermediate or middle portion C which takes the form of a hollow



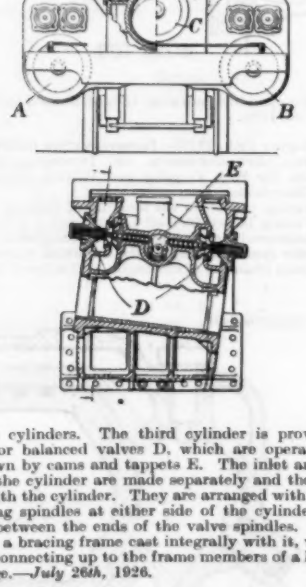
sleeve. One of the caps is fitted with a terminal D, the other electrical connection being made to a lug on the right-hand side of the top cap B. Within the body of the cut-out C is a valve member E which rests on the seat formed on a diaphragm in the aluminium alloy metal casing F, which below the diaphragm holds the insulated core G carrying the mercury duct. Between the valve member E and the walls of the casing F is a well formed to carry the ejected mercury, and an alternative current connection is provided by a series of spring fingers H. A manipu-

lating knob J is furnished for the purpose of resetting the cut-out by depressing the centre portion against a spring and so re-establishing the continuity of the mercury column after it has been broken.—*August 3rd*, 1926.

LOCOMOTIVES.

256,303. April 25th, 1925.—IMPROVEMENTS IN AND RELATING TO STEAM LOCOMOTIVE AND LIKE ENGINES AND TO THE VALVE BOXES THEREOF, William Dederich, of 4, Dean Stanley-street, Westminster.

This invention relates to locomotives or like engines in which three cylinders may be employed to drive a single crank axle or different shafts or axles. The two outer cylinders A and B are arranged in the same plane and between them is a third cylinder C which is so set that its axis is oblique to that of the

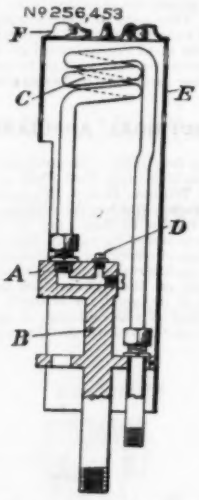


two outside cylinders. The third cylinder is provided with differential or balanced valves D, which are operated in the manner shown by cams and tappets E. The inlet and exhaust passages of the cylinder are made separately and they are cast integrally with the cylinder. They are arranged with the valves and operating spindles at either side of the cylinder and the cam shafts between the ends of the valve spindles. The third cylinder has a bracing frame cast integrally with it, which may be used for connecting up to the frame members of a locomotive undercarriage.—*July 26th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

256,453. December 10th, 1925.—IMPROVED MEANS FOR REMOVING SCALE FROM BOILER TUBES AND THE LIKE, Charles Robert Arcus, of 9, Poplar-road, Ramsgate.

According to this invention means for removing boiler scale from boiler tubes is provided by a liquid fuel burner which is accommodated in a cylindrical shell and may be attached to lengths of tubing, enabling it to extend the full length of the

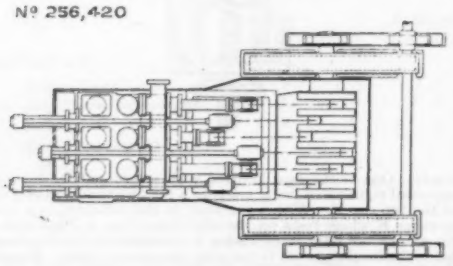


boiler tube. The burner A is attached to the shaft B and is provided with the usual heating coil C placed so as to receive the head of the ignited vapour issuing from the jet D. The coil is contained in a shell E with radially arranged openings and provided with deflecting blades F, by means of which the flame is directed towards the walls of the tube and the boiler scale is cracked away.—*August 12th*, 1926.

PUMPING AND BLOWING MACHINERY.

256,420. September 25th, 1925.—IMPROVEMENTS IN OR RELATING TO HYDRAULIC PUMPS, Hathorn, Davey and Co., Ltd., and Hugh Ralph Lupton, of Sun Foundry, Dewsbury-road, Leeds, Yorkshire.

This invention relates to hydraulic pumping machinery and

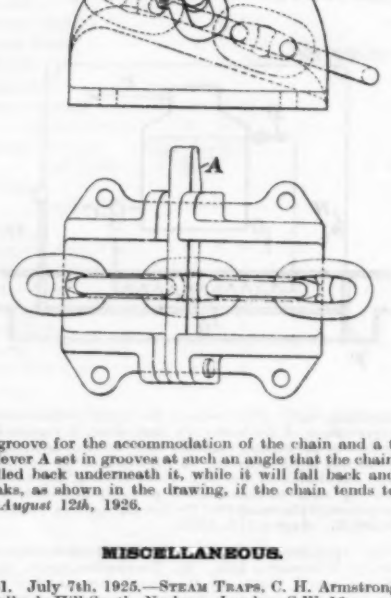


more particularly to pumps of the high-pressure three-throw type, its object being to reduce to a minimum the stresses and bending moment on the pump crank shaft. For this purpose for each of the three ordinary rams is substituted a pair of smaller rams adapted to work in contrary directions within a pair of opposed cylinders, arranged at the front and rear of the ram casing. Common suction and delivery valves for each pair of rams may be provided, securing thereby equal balance. Gearing of the type illustrated may be employed. By utilising three pairs of oppositely acting rams the thrusts on the connecting-rods will be neutralised by corresponding pulls reducing the stress on the crank shaft.—*August 12th*, 1926.

SHIPS AND BOATS.

256,437. October 23rd, 1925.—CABLE STOPPERS, Clarke, Chapman and Co., Gateshead-on-Tyne, and W. A. Woodeson.

This cable (chain) stopper is so devised that the chain may be heaved in, but will be checked, link by link, if it tends to run overboard again. It comprises a main casting with a longitu-

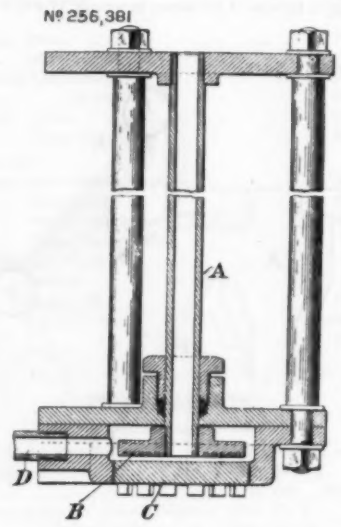


dinal groove for the accommodation of the chain and a transverse lever A set in grooves at such an angle that the chain may be pulled back underneath it, while it will fall back and jam the links, as shown in the drawing, if the chain tends to pay out.—*August 12th*, 1926.

MISCELLANEOUS.

256,381. July 7th, 1925.—STEAM TRAPS, C. H. Armstrong, 54, Pollards Hill South, Norbury, London, S.W. 16.

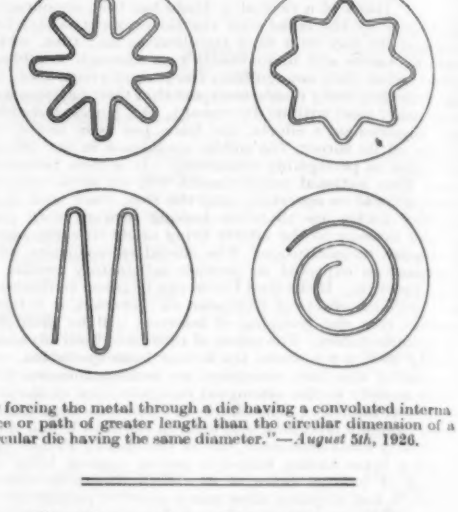
It would appear that the chief merits of this steam trap are a quick action and a labyrinthal packing, in the place of a normal valve seating. Its action depends on the relatively great expansion under the influence of heat of the tube A, which, when



steam passes down from the upper end, forces the disc B into contact with the adjustable plug C and cuts off the outlet. If the tube is cooled by the advent of water it contracts and a free outlet by way of D is provided for the water. The grooves in the disc B perform the functions of a labyrinth packing.—*August 12th*, 1926.

256,113. December 18th, 1925.—EXTRUSION OF SHEET METAL, The Broughton Copper Company, Ltd., and F. Tomlinson, 156, Blackfriars-road, Salford.

It would seem that the best way to cover this invention is to give the following quotation from the specification, together with one or two typical illustrations, which are self-explanatory :—"The manufacture of metal tubes by extrusion is well known and the manufacture of metal plates by flattening out an extruded tube slit longitudinally is also known, but tubes and sheets made by these known methods have been limited in perimeter by the internal diameter of the die. This is a disadvantage, as different dies must be used when sheets or tubes having different transverse dimensions or perimeters are required, and as the size of the die increases, the pressure required to extrude the metal must also be increased, and consequently heavier presses with greatly increased cost of working become necessary. We have discovered a means whereby a press of given maximum power may be used for forming a sheet or tube by extrusion, of a greater transverse dimension or perimeter than the internal perimeter of the normal circular die used therein and which hitherto it has not been possible to produce in such a press. We thus effect a great economy in working and in tools, as we are by this invention enabled to use a press for making that which hitherto a larger and more powerful press has been required. According to this invention we produce by extrusion metal sheets, tubes or the like of greater transverse dimension or perimeter than the internal perimeter of the normal circular die used in the press



by forcing the metal through a die having a convoluted interna face or path of greater length than the circular dimension of a circular die having the same diameter."—*August 5th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Paper, "Spun Pipes: Cast Iron and Concrete," by Mr. P. H. Wilson. 7.30 p.m.

TO-DAY AND SATURDAY, SEPTEMBER 17TH AND 18TH.

NATIONAL RADIO EXHIBITION.—Olympia, London. W. 1. 10.30 a.m. each day.

UNIVERSAL SMOKE ABATEMENT EXHIBITION.—Bingley Hall, Birmingham.

SATURDAY, SEPTEMBER 18TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—Visit to the Stourport super power station.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting of North-Eastern and Yorkshire Districts at Whitby, 12 noon.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Eastern District meeting at Epsom. 11 a.m.

TUESDAY TO THURSDAY, SEPTEMBER 21ST TO 23RD.

INSTITUTION OF GAS ENGINEERS.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual general meeting. 10 a.m. each day.

FRIDAY, SPETEMBER 24TH.

INSTITUTION OF FUEL ECONOMY ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "Liquid Fuels," by Dr. A. E. Dunstan. 6 p.m.

FRIDAY TO MONDAY, SEPTEMBER 24TH TO 27TH.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—Balliol College, Oxford. Third conference.

THURSDAY, SEPTEMBER 30TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Presidential address by Sir Seymour B. Tritton. 7.15 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—East Midland District meeting at Gainsborough. 11 a.m.

FRIDAY, OCTOBER 1ST.

FARADAY SOCIETY.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Discussion on "Physical Phenomena at Interfaces, with Special Reference to Molecular Orientation." 2.30 p.m.

WEDNESDAY, OCTOBER 6TH.

INSTITUTION OF SANITARY ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Reception and conversazione. Paper, "Housing Problems, with Special Reference to Subsidies and Rural Needs," by Mr. G. B. Chilvers. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

PROFESSOR VERNON HERBERT BLACKMAN, Sc.D., F.R.S., Professor Frederick George Donnan, C.B.E., D.Sc., LL.D., F.R.S., and Professor Frederick Alexander Lindemann, Ph.D., F.R.S., have been appointed by Order in Council dated August 20th, 1926, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in the place of members who have retired on the completion of their terms of office.

WATER SYSTEM IN BRAZIL.—The municipality of Gravata, State of Pernambuco, is about to undertake the construction of a new water supply system. Work is to be started not later than January, 1927, and completed within eighteen months. A considerable amount of equipment will be necessary and foreign manufacturers are invited to tender. Communications may be addressed in Portuguese to the chief engineer of the municipality.